EAVES HALL LODGES
MOOR LANE, WEST BRADFORD

FLOOD RISK ASSESSMENT
& OUTLINE DRAINAGE STRATEGY

Job Number: FRA 20 1222
Date: October 2020
Client: Emporia Leisure Ltd

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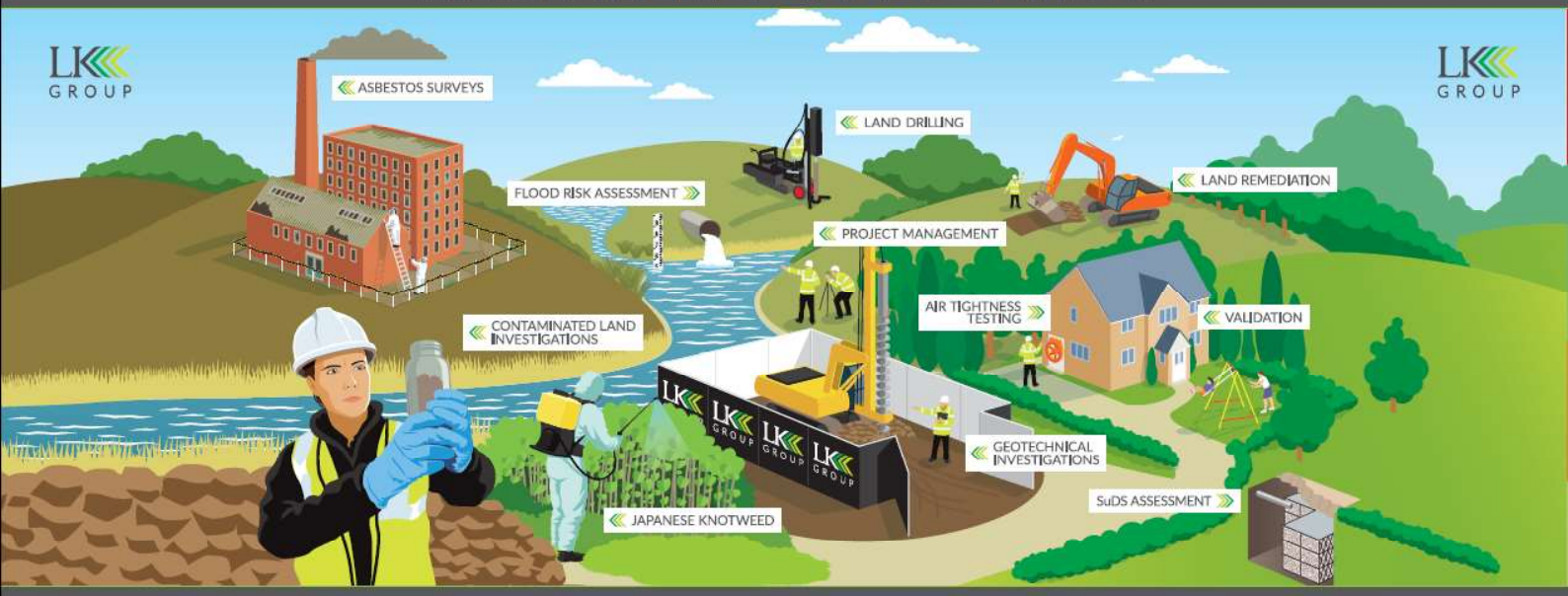

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LK Consult Document Verification			
Site Address	Land off Moor Lane, West Bradford, Clitheroe, Lancashire, BB7 3JG.		
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Job Number	FRA 20 1222	**Document Ref.**	FRA 20 1222 - R0
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EXECUTIVE SUMMARY

Scope and Background

This Flood Risk Assessment and Outline Drainage Strategy (FRA) has been undertaken by LK Consult Ltd (LKC) to support a planning application for the development of Eaves Hall Lodges, West Bradford. The development comprises construction of 15 eco-lodges with associated car parking.

LKC has prepared this FRA in line with the NPPF and Technical Guidance where appropriate.

In considering the proposals the following key principles have therefore been applied:

- Identification of flood risks.
- Protection of users of the new development.
- No increased flood risk to third parties.

Consultations

The Environment Agency (EA) has been consulted to inform the preparation of this report.

Lancashire County Council (LLFA), Ribble Valley Borough Council and United Utilities were also consulted concerning flood risk.

All relevant consultees have confirmed that there is a Negligible to Low risk of flooding to this site from all sources.

Flood Risk

Environment Agency flood maps indicate that the site is not vulnerable to fluvial flooding either from Drakehouse Brook, northeast of the site and from its tributary running along Eaves Hall Lane or from Greg Sike within the west of the site.

The site is shown on the Environment Agency's (EA) website Flood Zone Mapping as being in Flood Zone 1 (PPG Table 1).

The site is in Flood Zone 1 – Very Low Risk – annual probability of flooding less than 0.1% (1 in 1000).

The comparison of the flood extent with the topographic survey shows that the site is wholly in Flood Zone 1– Very Low Risk – annual probability of flooding less than 0.1% (1 in 1000).

There is a Low risk from pluvial sources within a limited area adjacent to the onsite watercourse.

Mitigation

Design

Site falls will be arranged to allow reasonably level access for occupants and visitors and allowing the site to be free-draining in case of local ponding at times of heavy rainfall. Floor levels of dwellings will be set as high as possible above the flood level giving regard to necessary access for the less-able.

The development will not result in any reduction in flood plain storage compared to the existing situation.

In considering the potential drainage options for the site at present it is assumed that surface water runoff arising from the development will discharge into the existing watercourse within the site boundary.

The proposed development will marginally increase the proportion of the site covered by impermeable surfaces and will therefore generate more runoff. Attenuation will therefore be required.

The outline drainage strategy considers the use of attenuation-based SuDS to be feasible with a discharge to the onsite watercourse to the western boundary. Therefore, the most effective strategy, in line with the SuDS management train, would be to have an attenuation pond at adjacent to the watercourse within the south of the site. The required pond or similar has been estimated to be **76.5 m^3** for the 1 in 30-year greenfield flow restriction.

Similarly, the estimated volume to be retained on site for the 1 in 100-year storm event including the allowance for climate change is between **143.0 m^3** and **185.3 m^3**.

The site is considered to be at Low risk of flooding. It is recommended that the minimum finished floor levels for the eco-lodges should be set at a nominal height above the proposed ground levels. This is to allow for overland flow during exceedance flows from an extreme event or a drainage failure.

Access

Access close to the site is elevated above potential flood levels and will always provide safe access to and from the site from Moor Lane to the east of the site.

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1 Introduction

1.1 Background

LK Consult Ltd (LKC) were commissioned by Emporia Leisure Ltd to carry out a Flood Risk Assessment (FRA) and Outline Drainage Strategy for Eaves Hall Lodges in West Bradford. The report was undertaken in support of a planning application (reference number 3/2020/0544) to redevelop the site for commercial use.

The report will address the vulnerability to flooding from all possible sources and will also consider the impact of the development on surface water runoff accounting for climate change and the potential to increase flood risk elsewhere. The Outline Drainage Strategy in Section 5 will provide an overview of the SuDS techniques which could be considered on the site. The issues of actual flood risk are discussed in Section 4.

Government policy with respect to development in flood risk areas is contained within the Department of Communities and Local Government National Planning Policy Framework[1] and accompanying Technical Guidance of March 2012 (revised to the Planning Practice Guidance (PPG)[2], which supersedes Planning Policy Statement 25 (PPS25) 'Development and Flood Risk'. The guidance on Climate Change allowance issued by the Environment Agency in February 2016 has also been considered.

LKC has prepared this Flood Risk Assessment (FRA) in line with the NPPF and the PPG where appropriate. The level of detail entered into any flood risk assessment is dependent upon the scale and potential impact of the proposed development, and the vulnerability classification of the proposed land-use.

SuDS should be designed where practical to maximise the opportunities and benefits that can be secured from surface water management. The strategy will consider the four 'pillars' of SuDS. To maximise these benefits, surface water management should be considered from the beginning of the development planning process and throughout influencing site and wildlife layout and design, and the use and characteristics of open spaces.

The main drivers for SuDS are the controlling water quantity and water quality[3] (Plate 1), with an increasing emphasis on amenity and biodiversity benefits where practical.

This report was prepared in line with the Ribble Valley Core Strategy Key Statement EN3 Sustainable Development & Climate Change and DME6[4] Water Management.

[1] DCLG (2019). "National Planning Policy Framework." Department of Communities and Local Government. February 2019.
[2] DCLG (2014). "Planning Practice Guidance" http://planningguidance.communities.gov.uk, April 2014.
[3] The SuDS Manual (C753) – CIRIA November 2015.
[4] Core Strategy 2008-2028 – A Local Plan for Ribble Valley, Reg 19 draft v7, Ribble Valley Borough Council, April 2012.

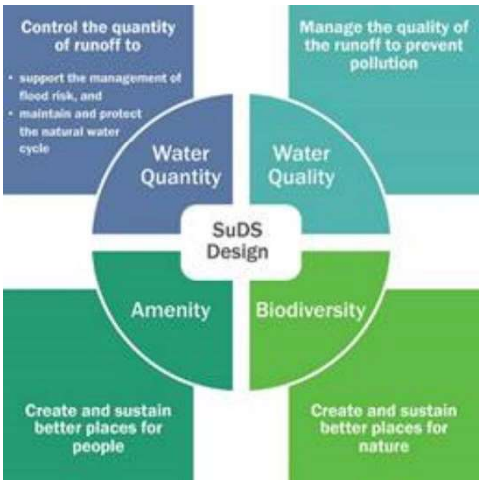

Plate 1: Four 'pillars' of SuDS design as defined by CIRIA in The SuDS Manual.

1.2 Site Details

A summary of the general site details is presented in Table 1-1. Plans, Drawings and Figures are provided in Appendix A. Figure 1 indicates the site location and boundary. Figure 2 indicates the proposed development.

Site Details	
Location	Land to the southwest of Moor Lane, to the northwest of Eaves Hall in West Bradford, Clitheroe, BB7 3JG. Centred at approximate National Grid Reference 373655E, 444990N.
Area	Approximately 1.8Ha.
Topography	134.5 metres above ordnance datum (AOD) in the northwest of the site and 121.3m AOD in the southeast. The site is sloping down to the southeast and towards the onsite watercourse.
Current Land Use	Site Grassed area to the majority of the site with mature trees along watercourse line and a compacted gravel access track off Moor Lane with some mounds of stored material present adjacent to it. The watercourse runs within the site along the western perimeter. Surrounding Area/ Boundary Treatment North: A lodge, Arable fields. East: Boundary drain/stream, Moor Lane. Southeast: Eaves Hall land. Southwest: Arable fields.
Proposed Development	Construction of 15 eco-lodges with associated car parking. Access will be from Moor Lane.

Table 1-1: Summary of site details.

2 Site Setting

2.1 Vulnerability

As an initial phase in identifying whether a site is potentially at risk of flooding, LKC has consulted the Environment Agency's (EA) website Flood Zone Mapping. This mapping is (often) based on coarse scale modelling and provides only an initial indication of the flood risk to a site. The Environment Agency Flood Zone maps were developed using a very coarse Digital Elevation Map (DEM) and are superseded by a more detailed analysis of modelled flood levels and topographic survey levels.

The Flood Zones divide the floodplain into three categories of flood risk, and do not take flood defences into account. The NPPF defines the Flood Zones as:

- Flood Zone 1 – little or no risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000).
- Flood Zone 2 – low risk, with annual probability of flooding of 0.1 to 1.0% from rivers and 0.1 to 0.5% from the sea.
- Flood Zone 3 – medium to high risk of flooding with an annual probability of flooding of 1.0% or greater from rivers, and 0.5% or greater from the sea.

The Flood Zone Mapping indicates the site as being within Flood Zone 1 in the PPG (paragraph 065, Table 1).

The development site is over 1 hectare in size, so under current regulations a Flood Risk Assessment will be necessary to accompany the Planning Application.

The proposed development is for camping site and this is classified within the 'Highly Vulnerable' category in the PPG (paragraph 066, Table 2).

2.2 The Sequential and Exception Tests

The NPPF does not require that the Sequential Test be applied to development proposals in Flood Zone 1. Since the site has been shown to be located in Zone 1 for flood risk (see section 4.1), a sequential approach should not be required for planning.

However, the principles should still be applied for developments within the site such that, for example, dwellings are situated on a high part of the site when there is a risk of local surface water flooding. The issues of actual flood risk are discussed below. The issues of safety and reduction in flood risk to others required by an Exception Test are also addressed in this document.

The Local Planning Authority (LPA) will make the final decision with regard to any planning application.

2.3 Environmental Setting

LKC has undertaken a review of public domain information including British Geological Survey data, Environment Agency data, historical mapping, and aerial photography to provide a summary of the environmental setting of the site. This is summarised in Table 2-1 below.

Summary of the Environmental Setting			
Geology	Superficial		Till, Devensian - Diamicton.
	Bedrock		Clitheroe Limestone Formation and Hodder Mudstone Formation (undifferentiated) - Mudstone.
	BGS Boreholes		BH Ref: SD74NW14, 170m north: Top soil to 0.1m, grey boulder clay to 14.7m, grey and brown Mudstone to 18.0m, grey shale to 22.5m, grey Mudstone to 28.9m dark grey Shale to 29.7m, hard black sandy Shale to 35.5m, Quartz to 35.6m, hard black sandy Shale to 47.3m, Limestone and Mudstone layers to 65.0m. Water level at 40m and 58m.
	Defra Soilscape Mapping		Slowly permeable, seasonally wet, acid, loamy and clayey soils have been identified within the site.
Hydrogeology	Aquifer Designation	Superficial	Secondary (undifferentiated).
		Bedrock	Secondary A. Site is not within a SPZ.
Hydrology	All adjacent and internal surface water		The watercourse within the western site boundary is Greg Sike, flowing southeast, discharging into the River Ribble over 1.4km away. There is a watercourse running adjacent to Moor Lane that flows towards West Bradford Brook. A reservoir/lodge is located adjacent to the north of the site surrounded by a low bund.
	Flooding		Flood Zone 1. Low to Medium risk of surface water flooding adjacent to Greg Sike.
Site History			Arable / pasture field from the earliest mapping. An onsite watercourse annotated as Greg Sike from the earliest mapping. A reservoir (lodge) annotated from the 1908 mapping.

Table 2-1: Summary of the Environmental Setting.

2.4 Site Reconnaissance

A site reconnaissance was undertaken in October 2020 and photographs are provided in Appendix B.

Relevant features identified on site are summarised below:

- Site access is off Moor Lane which ramps up to the site via a compacted gravel track which then becomes flat and then falls slightly towards the southwest.
- Site is comprised of a grassed area with an area of construction rubble adjacent to the access.
- Site falls towards the south and west falling towards Greg Sike. Undulations are present across the site. Mounds of stored material / construction waste observed by the access track.

- The watercourse noted to be at lower than the site levels by approximately 2m in the north to over 3m in the south of the site. It flows to the southeast.
- Mature trees noted growing along the watercourse.
- A reservoir/lodge with aquatic vegetation adjacent to the north of the site noted to be approximately 2m above the site levels, retained by the walls, and overgrown vegetation.
- A field boundary ditch runs across the fields to the north of the site intercepting overland flows before discharging into Greg Sike to the southwest.
- Highway drainage noted to be draining into the ditch along Moor Lane and a number of gullies were observed. The overflow water from the lodge is likely to overflow into that ditch.
- A deep concrete manhole / tank observed adjacent to the lodge.
- The area proposed for the car park noted to be falling gently towards the south.
- Piped crossing noted beneath the access to the site.
- Shallow excavations on site confirmed silty clay topsoil and clay strata below.

2.5 Site and Access Levels

A topographic survey of the site has been undertaken to OS GPS datum, and information is included on the drawings in Appendix B. The site falls northwest to southeast from 134.5m AOD to approximately 121.3m AOD. The plot proposed for a car park falls towards the road from 123.9m AOD to 123.4m AOD. The watercourse embankments are higher than the riverbed by around 2.0m in the north and to over 3m further downstream. The final site levels and floor levels of lodges have not yet been determined. The proposed access would join Moor Lane at around 121.5m AOD.

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3 Consultation

Information from consultees (Environment Agency (EA), Lancashire County Council - Lead Local Flood Authority, Ribble Valley Borough Council and United Utilities) is summarised in Table 3-1 below.

Relevant correspondence / information is provided in Appendices C (EA) and D (others).

Source	Details	
Environment Agency	Flood Zone 1: Very Low risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000).	
	Modelled Levels for the onsite watercourse	No information available.
	Records of Flooding	No records within, and within the vicinity of the site.
	Records of Flood Warning Service	Not within a flood warning service area.
	Surface Water Flooding	Small area of shallow Low to Medium risk of surface water flooding to a depth less than 300mm adjacent to the watercourse.
	Flooding from reservoirs	No risk from reservoirs.
	Groundwater Source Protection Zone (SPZ)	Not within SPZ.
	Additional information	The onsite watercourse is classed as an ordinary watercourse which is within the remit of the LLFA.
Lancashire CC (LLFA)	Lancashire County Council would normally require, that the Non-statutory technical standard for SuDS was followed. Therefore, the runoff from this greenfield site should be limited to greenfield runoff rates.	
Ribble Valley BC	Core Strategy Key Statement EN3: Sustainable development & climate change states that proposals should demonstrate how sustainable drainage system will be incorporated.	
United Utilities	Likely conditions for connecting into their sewerage system	All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80 of the National Planning Practice Guidance. Surface water runoff generated from this development should discharge to the ground via infiltration system where feasible. If confirmed that it is not feasible, UU suggests a connection into the nearby open watercourse, located on the north-eastern boundary or to investigate the possibility of draining surface water to the highway drains. If none of the options are proven to be feasible, a connection to the 150mm diameter public combined sewer located in Moor Lane at a pass forward flow to be agreed by the Lead Local Flood Authority. UU request that any agreed rate does not exceed 5l/s.

Table 3-1: Summary consultee information.

Source	Details	
United Utilities	Sewer map	No surface water sewer recorded in the area. There is a 150mm diameter combined sewer running across the fields along Moor Lane and the further in Moor Lane to the southeast of the proposed development.
Strategic Flood Risk Assessment (SFRA)	Level 1 SFRA[5]	The site has no history of flooding from any source.
Preliminary Flood Risk Assessment (PFRA)[6]	The Preliminary Flood Risk Assessment (PFRA)[3] for the area indicates that there are no records of flooding for the area which conforms with information supplied by the EA. The PFRA also indicates that the site is not in an area the most susceptible to groundwater flooding.	
Flood Risk Assessment (FRA)[7]	A preliminary site-specific FRA was carried out for this development in 2020 by Stanton Andrews Architects. It stated that the site is located within Flood Zone 1 with a low probability of flooding.	

Table 3-1 (continued): Summary consultee information.

[5] Strategic Flood Risk Assessment Level 1: Ribble Valley BC; 2010.
[6] Preliminary Flood Risk Assessment: Lancashire County, Blackpool and Blackburn with Darwen Borough Councils, 2011 (updated in 2017).
[7] Flood Risk Assessment: Stanton Andrews Architects; July 2020.

4 Assessment of Flood Risk

4.1 Flood Zones

The detailed flood map provided by the EA indicates that the site is fully in Flood Zone 1 (see Appendix C).

The EA did not provide any modelled levels for the stretch of Greg Sike or the Drakehouse Brook. Therefore, the comparison data was extracted by comparison with the flood map extents and the available topographical data provided for this site to determine the 100-year and 1000-year levels.

The 1% (100-year) flood levels are at around 106m AOD.
The 0.1% (1000-year) flood levels are at around 106.5m AOD.

The lowest site level is recorded at approximately 122.0m AOD. Therefore, the extents of the 1% & 0.1% flood levels remain outside of the development area.

The onsite watercourse noted to be at lower than the lowest levels on site by approximately 2m in the north to over 3m in the south of the site, therefore no risk of flooding should be posed to the development from that source.

4.2 Sources of Flooding

The risk of flooding from the following flood sources has been considered:

Fluvial – The EA has confirmed the study area is within Flood Zone 1. Therefore, the flood risk associated with this source is considered Very Low.

Tidal – The study area is remote from the sea and tidally influenced water bodies. Therefore, the flood risk associated with this source is considered Negligible.

Pluvial (Rainfall) – The surface water flood risk maps show small areas that have the potential to flood during prolonged heavy rainfall. These areas are associated with natural depressions that are likely to be removed/positively drained following the development process. These areas need consideration within the detailed design or there is the potential to have areas of standing water in landscaped areas not positively drained if overland flow routes are not considered. Therefore, the risk of flooding from surface water flooding is Low but should be considered further during the detailed design.

Surface Water (Overland flow) – This relates to surface water entering the site. Any surface water arising from the fields north of the site is likely to be intercepted by the existing field drain to the north and therefore pose no threat to the development. If there was a drainage failure causing overland flow it would flow towards the southern boundary. Therefore, the flood risk associated with this source is considered Very Low.

Groundwater – The BGS has groundwater records for the study area in the form of borehole records. The records show the water table is recorded at 40m below the surface. The superficial 'head' deposits are more than 14m thick which would make it unlikely for groundwater flooding to occur. No evidence of shallow groundwater was observed during the walkover. Therefore, the flood risk associated with this source is considered Negligible.

Sewers – United Utilities sewer records show combined sewers within the vicinity of the study area within the adjacent highway but there are no records of sewer within the site. There are no records of sewer flooding at the site location. The ditch / stream to the eastern boundary would intercept any overland flow before it enters the site. Therefore, the flood risk associated with this source is considered Negligible.

Artificial sources – According to the EA online maps, the study area is not at risk from reservoir flooding. The reservoir / lodge located to the directly to the north of the site is connected to ditches flowing to the southeast away from the site. The ditches at the perimeters of the site are generally free draining. Therefore, the flood risk associated with this source is considered Negligible.

4.3 Summary of Flood Risk

Source of Flooding	Risk Assessment Level
Fluvial	Very Low
Pluvial (Rainfall)	Low
Surface Water	Very Low
Tidal	Negligible
Groundwater	Negligible
Sewers	Negligible
Artificial Sources	Negligible

Table 4-1: Summary of Existing Risk Level.

The site is located within Flood Zone 1 and a Low risk of flooding from pluvial sources have been identified for the site. LKC therefore consider that a strategy for surface water management will be required at the site to mitigate the risk to others. The assessments of a range of measures that are feasible for the site are outlined in Section 5.

5 Surface Water Management

The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface run-off from development sites through the use of Sustainable Drainage Systems (SuDS), this being complementary to the control of development within the floodplain.

SuDS will not alleviate flooding in an area prone to flooding; however, properly designed SuDS have the potential to prevent the surface water runoff from new development worsening the flood risk. The effective disposal of surface water from development is a material planning consideration in determining proposals for the development and use of land.

The accepted principles are that surface water arising from a developed area should, as far as practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

The Building Regulations Requirement H3[8] stipulates that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of priority:

- an adequate soakaway or other adequate infiltration system,
- a watercourse or, where that is not practicable,
- a sewer.

The concept of a sustainable drainage system has been incorporated into the outline drainage strategy for the study area in order to comply with the Flood and Water Management Act 2010[9].

Suitability of different SuDS will be governed by prevailing site conditions, such as the type and scale of development, topography, ground conditions (soil permeability, ground stability, depth to water table), local hydrogeology and risk of groundwater contamination (presence of sensitive aquifers and source protection zones) etc.

5.1 Infiltration

The Groundwater Source Protection Zone mapping from the EA website shows that the site is not within any identified protection zones.

A summary of the British Geological Survey superficial and bedrock aquifer descriptions and classifications is shown in Table 5-1 below:

Classification	Description	Aquifer Classification	Recorded Water Table Depth	Soakaway Potential
Till, Devensian Deposits	Silty, sl. gravelly clay, boulder clay	Secondary (undifferentiated)	N/A	Limited
Clitheroe Limestone and Hodder Mudstone Formation Bedrock	Mudstone	Secondary A	40m & 58mbgl	Poor

Table 5-1: Geological and Hydrogeological Setting.

[8] Building Regulations part H3 2010: Approved Document, Drainage and Waste Disposal.
[9] Flood and Water Management Act 2010: UK Government.

Infiltration methods such as soakaways are unlikely to be feasible on the account of deep deposits of silty clay and boulder clay expected below the site, but this may be investigated further at the detailed design stage, if required.

5.2 Surface Water Drainage Strategy

There is a slope over the site and surrounding area which indicates that groundwater in the vicinity of the site would drain towards the south.

There is an open watercourse running through the west of the site and an open land drain / stream running adjacent to the eastern boundary that currently collect the surface water.

There are no surface water sewers within the vicinity of the site.

There is a combined sewer running adjacent to the southeast in Moor Lane.

The drainage options relating to the final discharge of surface water for this section of the site are listed in Table 5-2 in order of priority within the NPPF:

Option No:	Drainage Solution	Most feasible solution	Comments
a	Soakaway/Infiltration	3	Reasoning: low permeability of the underlying silty clay.
b	Connection to Watercourse	1	Connection into either onsite watercourse or the adjacent watercourse would be practical due to the close proximity to the site. This would require the LLFA land drainage consent.
c	Discharge into a sewer	2	Connection into a sewer would be accepted by UU if all different options of water disposal prove impractical. The nearest combined sewer manhole is located adjacent to the southeast corner of the site. A connection is possible – subject to approval from LLFA/UU.

Table 5-2: Drainage options.

Table 5-3 provides a summary of the SuDS options appraisal with consideration of CIRIA C753 (The SUDS Manual)[10] for the development:

SuDS Option	Appropriate to Development	Comments	Benefits	Comments
Infiltration				
Soakaways	X	Due to the nature of the ground conditions, the use of infiltration systems may not be feasible.	Water quantity Water quality	Soakaways provide stormwater attenuation, stormwater treatment and groundwater recharge. Runoff is treated by physical filtration to remove solids, by absorption into the soil and removal and by biochemical reactions involving micro-organisms growing on the soil.
Infiltration basin	X	Depressions that store and dispose of water via infiltration. May not be appropriate given the ground conditions.	Water quantity Water quality Biodiversity Amenity	Infiltration basin reduces the volume of runoff from a drainage area, can be very effective at pollutant removal via filtering through the soils, contributes to groundwater recharge and baseflow augmentation. Runoff is treated by physical filtration to remove solids, by absorption into the soil and removal and by biochemical reactions involving micro-organisms growing on the soil.
Infiltration trench	X	Infiltration trenches are shallow excavations with rubble or stone.	Water quantity Water quality Amenity	An Infiltration trench can create temporary subsurface storage of stormwater runoff, thereby enhancing the natural capacity of the ground to store and drain water. Infiltration trenches allow water to dissipate into the surrounding soils from the bottom and sides of the trench where runoff is treated by physical filtration, adsorption and biochemical reactions involving micro-organisms growing in the soil. Infiltration trenches are easy to integrate into a site. They are ideal for use around playing fields, recreational areas or public open space.
Rain gardens	*	Rain gardens are relatively small depressions in the ground that are planted up with native vegetation. Most likely to be implemented on private property close to buildings on relatively flat areas.	Amenity Biodiversity Water quality Water quantity	Attractive features that can help to improve open space. Can be planned as landscaping features. Flexible layout to fit into landscape. Runoff can be treated by physical filtration to remove solids, by absorption and removal by biochemical reactions involving micro-organisms growing on the soil. They can reduce rate of run off and provide some volume reduction.
Filtration				
Filter drain / trench	✓	Linear trenches filled with a permeable granular material, often with a perforated pipe in the base of the trench.	Water quantity Water quality	Filter trenches create temporary subsurface storage of stormwater runoff and provide stormwater treatment. These trenches can be used to filter and convey stormwater to downstream SuDS components.
Filter strip	✓	Engineered filters that use vegetation to remove and treat runoff. The filter strip is sloped to allow sheet flow across the vegetated strip. May be appropriate given the site topography.	Water quality Amenity Biodiversity	A filter strip offers no storage and is used solely to remove pollutants from surface water. The vegetation traps organic and mineral particles that are then incorporated into the soil, while the vegetation takes up any nutrients. A filter strip features medium amenity potential. Local wild grass and flower species can be introduced for visual interest and to provide a wildlife habitat.

Table 5-3: Summary of the SuDS options appraisal.

[10] CIRIA C753 - The SUDS Manual. London 2015.

SuDS Option	Appropriate to Development	Comments	Benefits	Comments
Retention & Detention				
Detention basin	✓	Dry depressions designed to hold water for a specific retention time. Basins tend to be found towards the end of the SuDS management train, so are used if extended treatment of the runoff is required or if they are required for wildlife or landscape reasons.	Water quantity Water quality Biodiversity Amenity	Detention basins provide flow control through attenuation of stormwater runoff for a wide range of rainfall events. Basins treat runoff in a variety of ways: settlement of solids in still or slow moving water, adsorption by the soil, biological activity. Basins offer many opportunities for the landscape designer. Basins should not be built on but can be used for sports and recreation. Basins can be part of public open space.
Attenuation Ponds	✓	Attenuation ponds can be used to offset the increase in surface water flows attributable to increased area of hard standing, in order to minimise the risk of flooding to and from the proposed development.	Water quantity Water quality Biodiversity Amenity	Ponds will attenuate the surface water flow prior to discharging to the public surface water sewers. The storage volume afforded by these features should not include any permanent water in the pond. Ponds treat runoff in a variety of ways: settlement of solids in still water (having plants in the water enhances calm conditions and promotes settlement), adsorption by aquatic vegetation, biological activity. Permanently wet ponds can be used to store water for reuse and offer excellent opportunities for the provision of wildlife habitats. Ponds can be part of public open space.
Geo-cellular storage systems	✓	Modular block systems can be used to provide an underground storage facility. Any geo-cellular storage systems should be lined with a geo-membrane to provide attenuation storage.	Water quantity	Geo-cellular systems can be used to control and manage rainwater surface water runoff either as a soakaway or as a storage tank. Geo-cellular storage systems provide high storage volume capacity High void ratios (up to 96%). Capable of managing high flow events.
Oversized Pipes	✓	Oversizing the pipes that make up the on-site drainage network is a cost-effective method for providing attenuation storage within the network. Such systems could be considered on the parts of the development where gradients are relatively flat.	Water quantity	Oversized pipes can reduce rate of run off and provide some volume reduction.
Tanks	✓	Prefabricated underground tanks could be considered at the detailed design stage in order to provide storage to attenuate surface water runoff.	Water quantity	Storage tanks can be used to control and manage rainwater surface water runoff providing high storage volume capacity. Tanks are capable of managing high flow events.

Table 5-3 (continued): Summary of the SuDS options appraisal.

SuDS Option	Appropriate to Development	Comments	Benefits	Comments
Swales & conveyance channels				
Swales	✓	Swales are shallow grass-lined channels that provide capacity for conveying flows at a controlled rate into ponds and watercourses.	Water quality Biodiversity Amenity Water quantity	Swales are effective at removing polluting suspended solids through filtration and sedimentation. The vegetation traps organic and mineral particles that are then incorporated into the soil, while the vegetation takes up any nutrients. Swales are often integrated into the surrounding land use. Local wild grass and flower species can be introduced for visual interest and to provide a wildlife habitat. Swales are usually designed as conveyance systems but can also be designed with check dams to increase attenuation and, where applicable, infiltration.
Channels & rills	✓	Channels and rills are open surface water channels with hard edges.	Water quality Amenity Water quantity Biodiversity	Effective in water & pollution treatment. Can act as pre-treatment to remove silt before water is conveyed into further SuDS features. Can be visually appealing in urban landscapes. Amenity value for the local community and biodiversity value (design dependant).
Control structures				
Flow control devices	✓	Flow control devices e.g. hydro-brake style flow control systems, and restricted orifices enable the discharge to be restricted to a constant rate from the development.	Water quantity	Control the peak flow. Complex controls can reduce upstream storage requirements.
Inlets, outlets and controls	✓	There are many different designs and variations, including landscaped pipes, perforated pipes, weirs.	Water quality Amenity	Inlets, outlets and other control structures are key elements of well-designed SuDS. Inlet and outlet features allow water to flow into and out of features and also limit the rate at which water flows along and out of the system. There are many different approaches and products available and they can be easily designed to add interest to the urban landscape. Can provide accurate flow control from one SuDS feature to another.
Source control				
Green roofs	✓	Green roofs comprise a multi-layered system that covers the roof of a building or podium structure with vegetation cover/landscaping.	Water quality Water quantity Amenity Biodiversity	Green roof installations can help to reduce surface water runoff from roof areas depending on the system specified. Good removal capability of atmospherically deposited urban pollutants. Ecological, aesthetic and amenity benefits.
Blue roofs	*	A blue roof is a roof design that is explicitly intended to store water, typically rainfall.	Water quantity Amenity Biodiversity	Blue roofs are designed to attenuate and manage stormwater on a flat roof in urban areas where options for ground-based attenuation systems are limited, and in particular, where construction is being carried out within flood sensitive areas. Amenity value for the local community.

Table 5-3 (continued): Summary of the SuDS options appraisal.

SuDS Option	Appropriate to Development	Comments	Benefits	Comments
Rainwater harvesting	*	Rainwater harvesting collects the rain which falls onto roofs, then stores it in a tank until required for a non-potable use.	Water quantity	In the process, a volume of water is kept out of the storm-water management system, thereby helping to reduce flooding risks. When required, the water is pumped to the point of use, thus displacing what would otherwise be a demand for mains-water. Reduces demand on mains water.
Permeable Pavements – with granular and geo-cellular storage systems	✓	Permeable pavements allow inflow of rainwater into underlying construction. Any geo-cellular storage systems would have to be lined with an impermeable membrane to provide storage rather than infiltration for runoff from highways.	Water quality Water quantity	Reduced peak flows to watercourses, reducing the risk of flooding downstream. Reduced effects of pollution in runoff on the environment.
Other SuDS				
Wetlands	✓	These comprise of shallow ponds and marshy areas, covered almost entirely in aquatic vegetation.	Water quality Water quantity Amenity Biodiversity	Wetlands provide both stormwater attenuation and treatment. Wetlands detain flows for an extended period to allow sediments to settle, and to remove contaminates by facilitating adhesion to vegetation and aerobic decomposition. They also provide significant ecological benefits.

Table 5-3 (continued): Summary of the SuDS options appraisal.

Notes

✓ Suitable for use given the nature and scale of the development
* Possibly suitable for use – not included in the client and architect design proposal at present
X Not suitable

5.3 Surface Water Attenuation Requirements

From the LLFA requirements the flow should be limited to a 'greenfield scenario' for estimating the attenuation volumes required.

It is estimated from the supplied plan (see Appendix A) that the site will have the following designated areas (Table 5-4). Table 5-4 shows the assumed split in area included within the calculations.

Designated Areas	Plot Area
Total area (ha)	1.80
Catchment Area (ha)	1.26
Impermeable split (ha)	0.10
Permeable split (ha)	1.16

Table 5-4: Assumed plot areas.

5.3.1 Attenuation Estimate

Surface water storage and greenfield runoff estimations based on the HR Wallingford procedure (IH 124[11]) have been undertaken for the development and the output report is presented in Appendix E.

For the contributing catchment, an estimate has been produced assuming a developable area of 1.26ha and a green infrastructure of 0.54ha from the 1.80ha plot. The proposed car park is proposed of compacted gravel, therefore assumed impermeable, whereas the proposed eco lodges and surrounding footpaths are assumed permeable. This gives the following runoff rates and attenuation requirements for this section based on the Wallingford IH 124 method:

- Q_{bar}: 13.33 l/s
- 1 in 1-year greenfield runoff rate: 11.33 l/s
- 1 in 30-year greenfield runoff rate: 22.39 l/s
- 1 in 100-year greenfield runoff rate: 27.99 l/s

The following attenuation has been estimated for the development using greenfield runoff rates and utilises the FSR methodology[12] as:

- Attenuation storage volume: **76.5 m^3** (1 in 30-year event)
- Retention on site volume: **143.0 m^3** (1 in 100 year + 20% Climate Change)
- Retention on site volume: **185.3 m^3** (1 in 100 year + 40% Climate Change)

Attenuation storage aims to limit the peak rate of runoff from the development to the corresponding greenfield runoff for a range of annual flow rate probabilities before discharge to watercourse. As the flow from the development would be restricted to the greenfield equivalent there should be little change in the flows that enter the unnamed watercourse and thus the risk of flooding and the level of erosion created as a result from the development should not increase the risk of flooding off-site.

The attenuation required for a 1 in 30-year storm event, requires a storage volume of **76.5 m^3** and for the 1 in 100-year event, a storage capacity of between **143.0 m^3** and **185.3 m^3** will be required from on-site storage as well as SuDS systems. All volumes can be stored within the site boundary and discharges will be limited by flow control devices to the on-site watercourse.

[11] IH124 Flood Estimation of Small Catchments.
[12] Flood Studies Report Wallingford NERC 1975.

5.4 Site Specific SuDS

The use of attenuation pond or similar deem to be the most feasible and practical option for the development. The pond will provide required storage volume to limit peak runoff arising from the development and will also provide amenity and ecological benefits.

Utilising of a flow control device at the end of the system will control the peak flow rates.

There are areas where conveyance systems such as swales may be utilised to intercept overland flow arising from the site and to convey any water to the proposed pond. This will provide an effective pre-treatment of suspended solids through filtration and sedimentation and will also provide ecological and amenity benefits. Shallow swales could be installed along the watercourse and to the south of the proposed car parking.

The area outside the swale would flow naturally into the existing watercourse.

The use of permeable paving may be viable dependant on the detailed design of the proposed development. If this drainage technique is considered to be feasible then it will reduce the requirement for attenuation as it will reduce the contributing impermeable area. The permeable paving will also provide some level of water treatment reducing effects of pollution in runoff on the environment.

Assuming that the outline drainage strategy is acceptable to the Local Authority, a more detailed design can be presented and agreed with the appropriate regulatory bodies during the detailed design phase.

6 Mitigation Measures

6.1 Proposed Site levels and Developments Level

Current Environment Agency guidance recommends that the minimum ground floor levels of residential developments are set above the 1% annual probability (1 in 100 year) flood level including an additional fluvial allowance for climate change. It is generally accepted that vehicle parking can be accommodated within the flood zone with suitable safeguards. The 'design' flood level for the site should therefore be the 1% annual probability event with allowance for climate change plus an allowance for freeboard.

The site is proposed for the eco-lodges which will not be permanently occupied during a year.

The 1% annual probability event with allowance for climate change and the 0.1% annual probability (1 in 1000-year) are below the lowest existing ground level measured on site by approximately 15.5m. On this basis the finished floor levels of the lodges (FFL) should be set at a nominal height above the finalised ground levels to allow for any overland flow from a drainage failure. No further mitigation measures are therefore recommended.

6.2 Safe Access

Safe and dry access is available via Moor Lane (121.5m AOD) at 15.5m above the 1% annual probability event (106m AOD). Therefore, no mitigation is proposed.

6.3 Flood Resistance and Resilience

The development proposed may be subject to flooding at more extreme events than those considered. However, the risk appears to be sufficiently low that flood resilience measures need not be included into floor construction to aid recovery after any event. If utilised, typical measures would include solid floors, use of suitable materials and services with outlets at high level. The need can be discussed and agreed with building control officers during detailed design.

6.4 Residual Risk

It is impossible to completely guard against flooding since extreme events greater than the design standard event are always possible. However, it is likely that with the 1% annual probability flood event with allowance for climate change significantly below the lowest site levels, the relatively elevated position of the development will safeguard it from localised fluvial flooding during extreme rainfall events and fluvial flooding events outside the scope of this assessment. However, floor levels should be set above proposed levels across the site and provide a nominal freeboard to allow overland flow under exceptional conditions. Overland flow routes should be considered in case of drainage failure and the extreme events.

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7 Conclusions

The site is shown on published mapping to be located within the Environment Agency's Flood Zone 1. Comparison of topographical data with the EA modelled flood level data indicates that the whole site is in Flood Zone 1 – Very Low Risk of fluvial flooding.

Low risks of flooding from pluvial sources have been identified across the limited area adjacent to the onsite watercourse from information provided by EA.

An assessment of these risks in conjunction with the development proposals have resulted in the following recommendations for the safe development of the site:

- The finished floor level of the pods should be set at a nominal height above the finished ground levels to allow for overland flow routes in extreme events and drainage failures.
- Pedestrian and vehicular safe access to and from the site is achievable under all conditions via the access road off Moor Lane.
- Potential for soakaway use for rainwater disposal is low; however, this could be investigated further at the detailed design phase.
- Surface water flow will probably need to be attenuated to the greenfield runoff rate or a rate agreed with the LLFA.
- Surface water arising from the site could potentially discharge into the onsite watercourse.
- Proposed SuDS should be selected to provide a wide range of benefits including amenity, biodiversity and maintaining water quality where practical. During construction, adequate measures should be proposed to control pollution to existing watercourses and groundwater.
- A formal evacuation plan is not required.

Further details on the proposed mitigation measures are provided in Section 6. All proposed measures should be agreed with the Local Authority prior to commencement of the development.

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Appendix A

Figures, Plans and Drawings

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Client: Emporia Leisure Ltd				Title: Site Location & Boundary Plan	LK CONSULT LIMITED
Site: Eaves Hall Lodges, West Bradford					
Job No.: FRA 20 1222	Drawn By: AM	Checked By: MJ	Drawn: Oct 2020	Scale (see scale bar): 1:25,000 & 1:2,500 @ A4	Figure: 1 / Revision:

Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.

LK CONSULT LIMITED

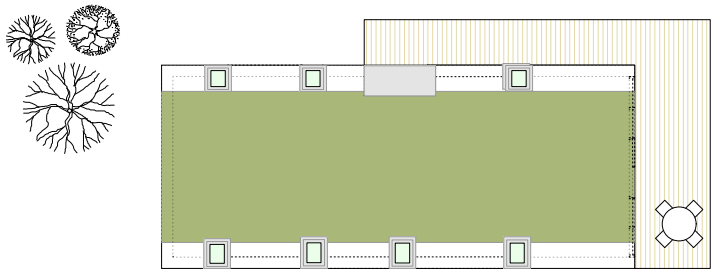
Client: Emporia Leisure Ltd

Site: Eaves Hall Lodges, West Bradford

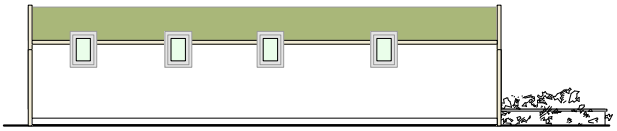
Title: Proposed Site Use

Job No.:	Scale (See Scale Bar):	Figure:	Revision:
FRA 20 1222	NTC	2	

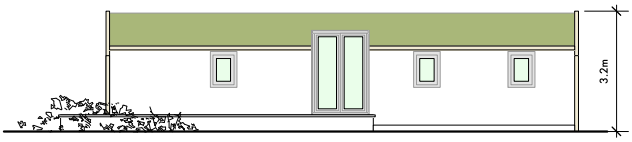
Drawn By:	Checked By:	Drawn:
AM	MJ	Oct 2020



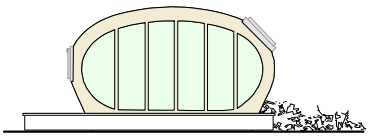
roof plan - 2 bed
Scale: 1:100



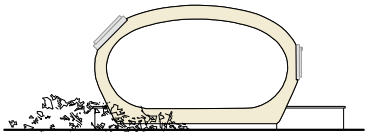
south elevation
Scale: 1:100



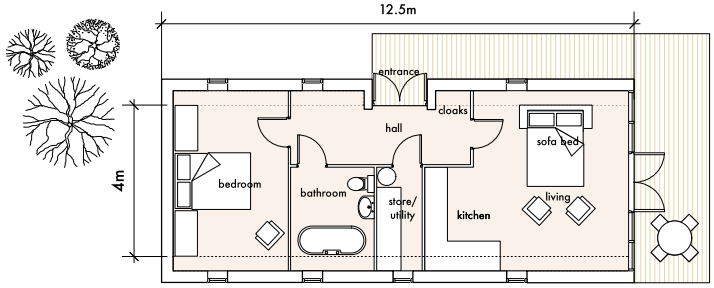
north elevation
Scale: 1:100



west elevation
Scale: 1:100



east elevation
Scale: 1:100



floor plan - 2 bed
Scale: 1:100

N

0m 10m scale

MATERIALS
timber structure
sedum roof
aluminium windows
lime render or timber clad finish

NOTE
pods are pre fabricated and can be raised up or placed directly onto landscape

A	Issued for planning	July 18

stanton andrews
architects

44 york street
clitheroe
BB7 2DL

t 01200 444490
e mail@stantonandrews.co.uk
w stantonandrews.co.uk

Eaves Hall Lodges

Proposed Eco Lodge
2 Bed

drg.no. 1813 / PL03 rev. A
drawn. gw date. July 18 scale. 1 to 100 @A3

Appendix B

Site Information

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N

0m 10m 20m
scale

A - Issued for planning july 2018

stanton andrews
architects

44 york street
clitheroe
BB7 2DL

t 01200 444490
e mail@stantonandrews.co.uk
w stantonandrews.co.uk

Eaves Hall Lodges

Existing Site Plan

dwg.no 1813/ EX01 rev. A

drawn gw date july18 scale 1:500 @ A1

SD 74 NW 14

GROUNDWATER
DATE RECEIVED 26 · 2 · 96

FORM WR-38

National Rivers Authority
..... **Region**

NRA No. SD 74/63

(Please type)

BOREHOLE RECORD

A. SITE DETAILS

Borehole drilled for	MR COWBURN. CONSENT Nº 861.
Location	THREE RIVERS CARAVAN PARK, CLITHEROE,
NGR (8 fig.)	SD 73744525 Please attach site plan
Ground Level (If known) ..	
Drilling Company	DALES WATER SERVICES LTD
Date of drilling	Commenced: 31 10 95 Completed: 4 11 95

B. CONSTRUCTION DETAILS

Borehole datum (If not ground level)..... EDGE OF CHAMBER above m below GL
(point from which all measurements of depth are taken eg flange, edge of chamber, etc)

Borehole drilled diameter ..... 150 mm from G.L to 65 m/depth
_____ mm from _____ to _____ m/depth
_____ mm from _____ to _____ m/depth

Casing material and type (eg plain steel, plastic slotted): PLAIN STEEL diameter 150 mm from GL to 19 m/depth
SLOTTED STEEL diameter 125 mm from 18 to 65 m/depth
_____ diameter _____ mm from _____ to _____ m/depth
_____ diameter _____ mm from _____ to _____ m/depth

Grouting details .....

Water struck at ..... 40m, 58m m (depth below datum - mbd)
62.90m m (depth below datum - mbd)

Rest water Level on completion ..... 33.50 mbd

C. TEST PUMPING SUMMARY (Please supply full details on Forms WR-39)

Test Pumping Datum (If different from borehole datum): EDGE OF CHAMBER above m below borehole datum (mbd)

Pump Suction Depth ..... 50 mbd

Water Level (Start of Test) ..... 32.32 mbd

Water Level (End of Test) ..... 32.36 mbd

Pumping rate ..... 272 m³/d ~~l/s~~

for 3 days/~~hours~~

Recovery to ..... 32.36mbd in 2 ~~mins/hrs~~ : days
(from end of pumping)

Date(s) of measurements ..... 2/2/96 – 10/2/96.

GROUNDWATER

DATE RECEIVED 26 · 2 · 96

FORM WR-38 (cont.)

NRA No.

(Please type)

D. STRATA LOG SD 74/63 THREE RIVERS CARAVAN PARK ABH.

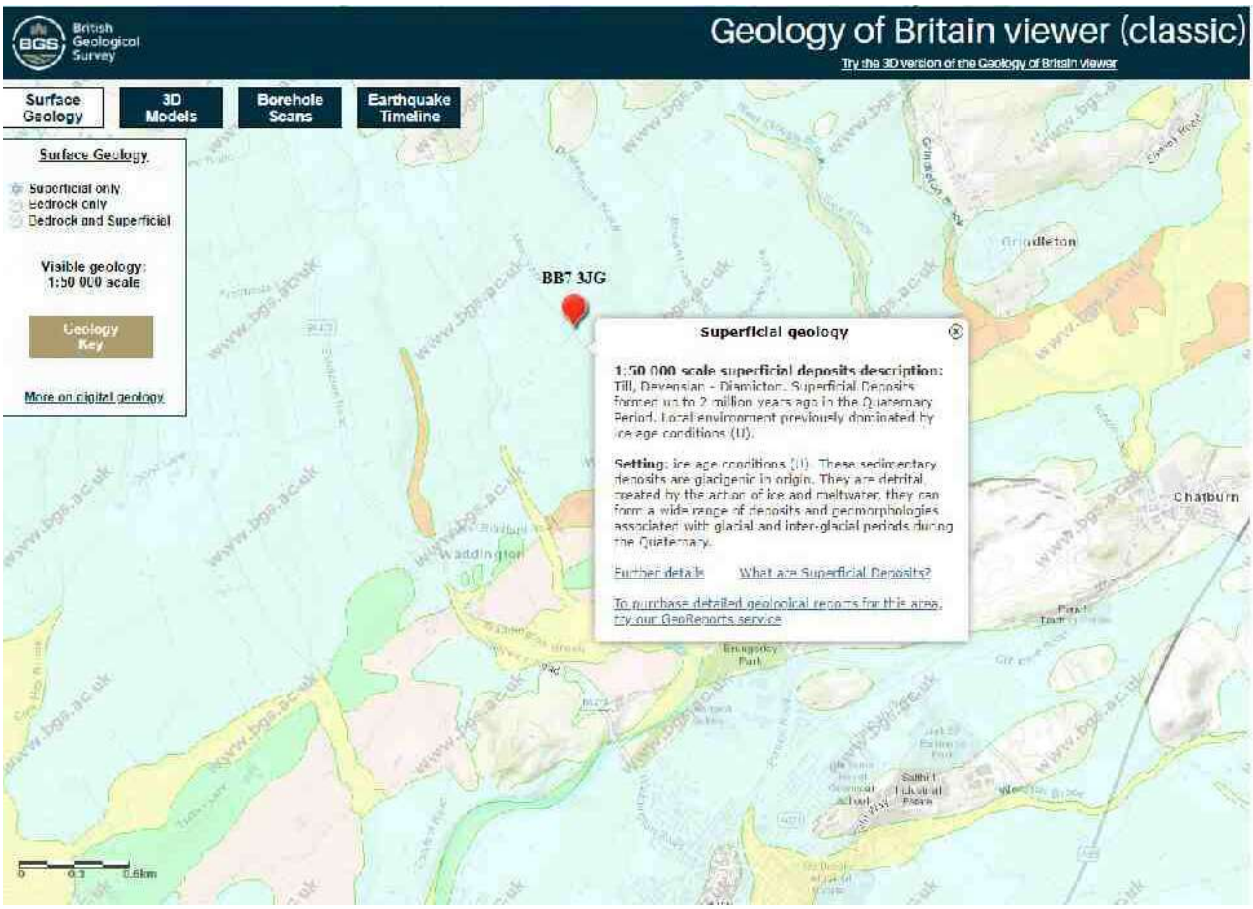
Geological Classification (BGS only)	Description of strata	Thickness m	Depth m
	TOP SOIL	0 - 10	0 - 10
	GREY BOULDER CLAY	14 · 60	14 - 70
	GREY AND BROWN MUDSTONE	3 · 30	18 · 00
	GREY SHALE	4 · 50	22 - 50
	GREY MUDSTONE	6 · 40	28 · 90
	DARK GREY SHALE	0 · 80	29 · 70
	HARD BLACK SANDY SHALE	5 · 80	35 · 50
	QUARTZS	0 · 10	35 · 60
	HARD BLACK SANDY SHALE	11 · 70	47 · 30
	BLACK LIMESTONE	1 · 70	49 · 00
	BROWN MUDSTONE	0 · 20	49 · 20
	BLACK LIMESTONE	6 · 30	55 · 50
	BLACK SHALE	0 · 80	56 · 30
	BLACK LIMESTONE	1 · 70	58 · 00
	BROWN MUDSTONE	0 · 80	58 · 80
	BLACK SHALE	4 · 10	62 - 90
	GREY & BLACK BROKEN LIMESTONE	1 · 10	64 - 00
	BLACK SHALE	1 - 00	65 - 00

[continue on separate page if necessary]

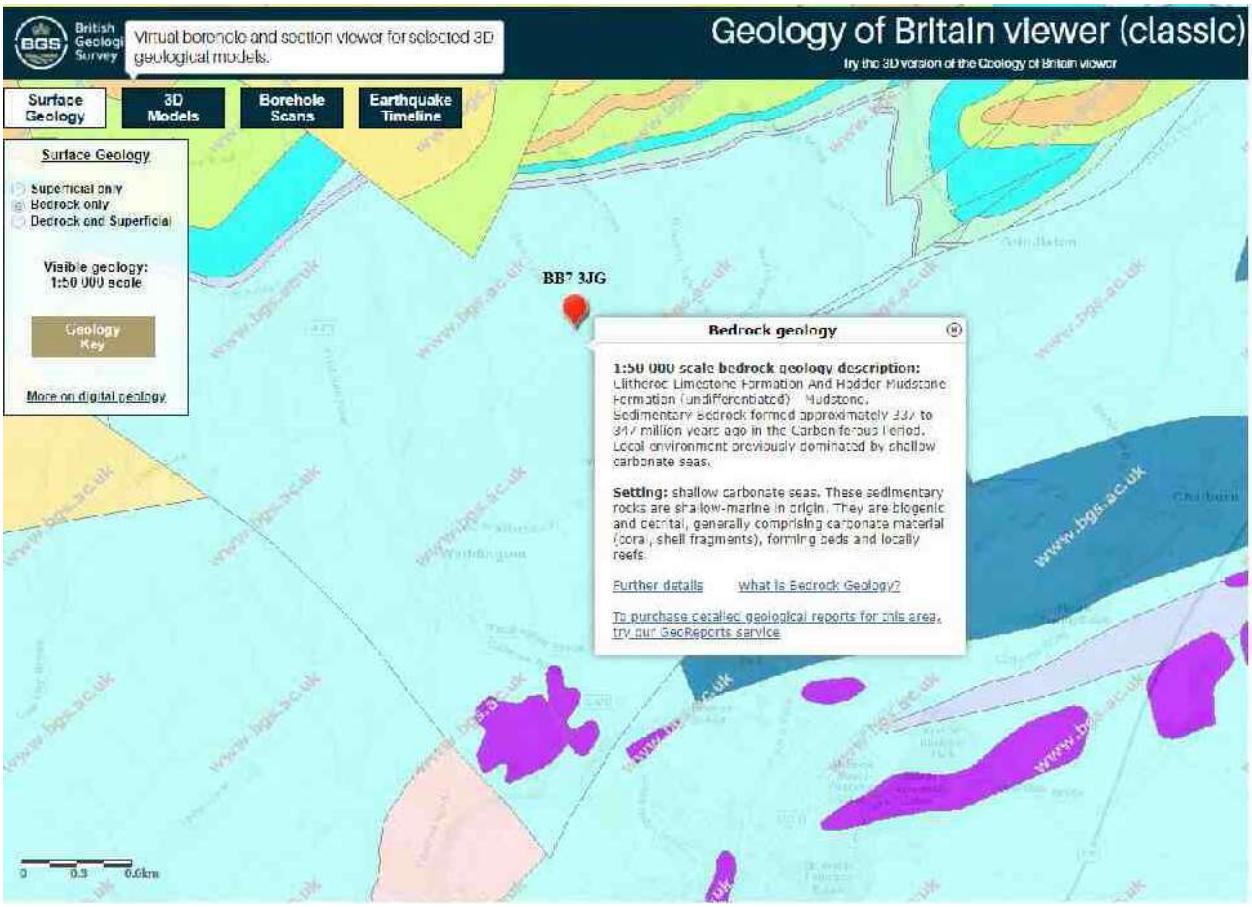
Other Comments (eg gas encountered, saline water intercepted, etc)

FOR OFFICIAL USE ONLY

FILE ..... CONSENT NO ..... BGS REF NO .....



BGS – Superficial Geology



BGS – Bedrock Geology

Defra – Soilscape Mapping

	**Photograph 1 (facing NE):** View of the existing access track towards the site entrance off Moor Lane.
	**Photograph 2 (facing N):** View across the site towards the northern boundary.
	**Photograph 3 (facing E):** Area proposed for a car park to the right of the existing access track.

	**Photograph 4 (facing N):** View across the east of the site.
	**Photograph 5 (facing N):** View across the site towards a lodge.
	**Photograph 6 (facing W):** View towards the western boundary and an onsite watercourse.

	**Photograph 7 (facing N):** A high wall surrounding the lodge.
	**Photograph 8 (facing S):** The lodge located off site, adjacent to the north.
	**Photograph 9 (facing SE):** Manhole cover adjacent to the lodge.

	**Photograph 10 (facing W):** View along the northern boundary.
	**Photograph 11 (facing S):** View across the site towards Eaves Hall.
	**Photograph 12 (facing SE):** View along the eastern boundary.

	**Photograph 13 (facing NE):** A drain running between the site and Moor Lane at few meters below the site levels.
	**Photograph 14 (facing SE):** Drain crossing beneath the site entrance.
	**Photograph 15 (facing NW):** Highway gullies in Moor Lane.

	**Photograph 16 (facing W):** Onsite watercourse. Photograph taken upstream within the northeast of site.
	**Photograph 17 (facing NW):** Onsite watercourse. Photograph taken further downstream, at the centre of the western boundary.
	**Photograph 18 (facing NW):** Onsite watercourse. Photograph taken further downstream, in the vicinity of the access track

	**Photograph 19 (facing E):** View from the watercourse towards the site.
	**Photograph 20 (facing SW):** Photograph taken further downstream, off site.
	**Photograph 21 (facing W):** Photograph taken further downstream, off site.

Appendix C

Environment Agency Data

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Flood map for planning

Your reference	Location (easting/northing)	Created
FRA 20 1222	**373677/444962**	**30 Sep 2020 11:45**

Your selected location is in flood zone 1, an area with a low probability of flooding.

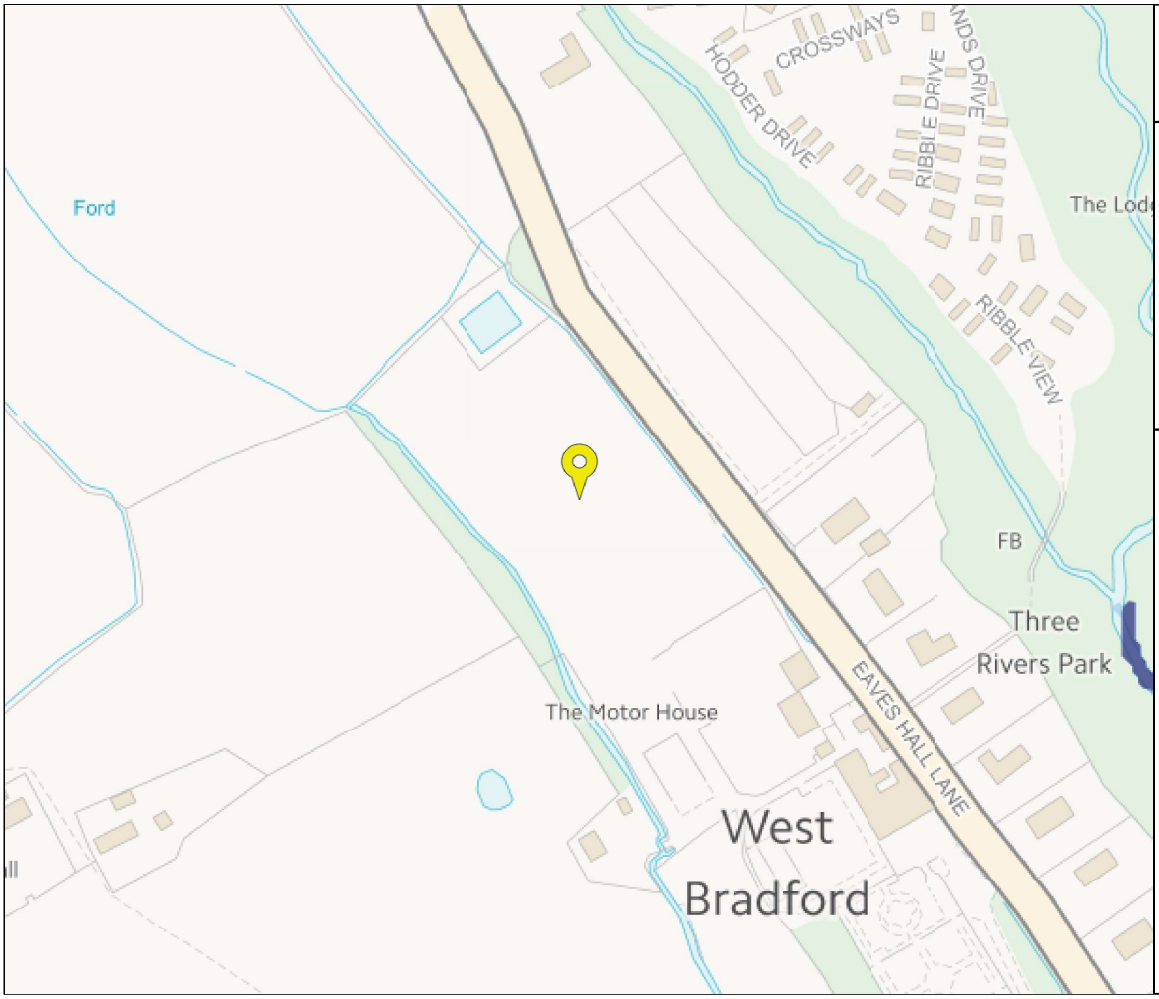
This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.



Environment Agency

Flood map for planning

Your reference
FRA 20 1222

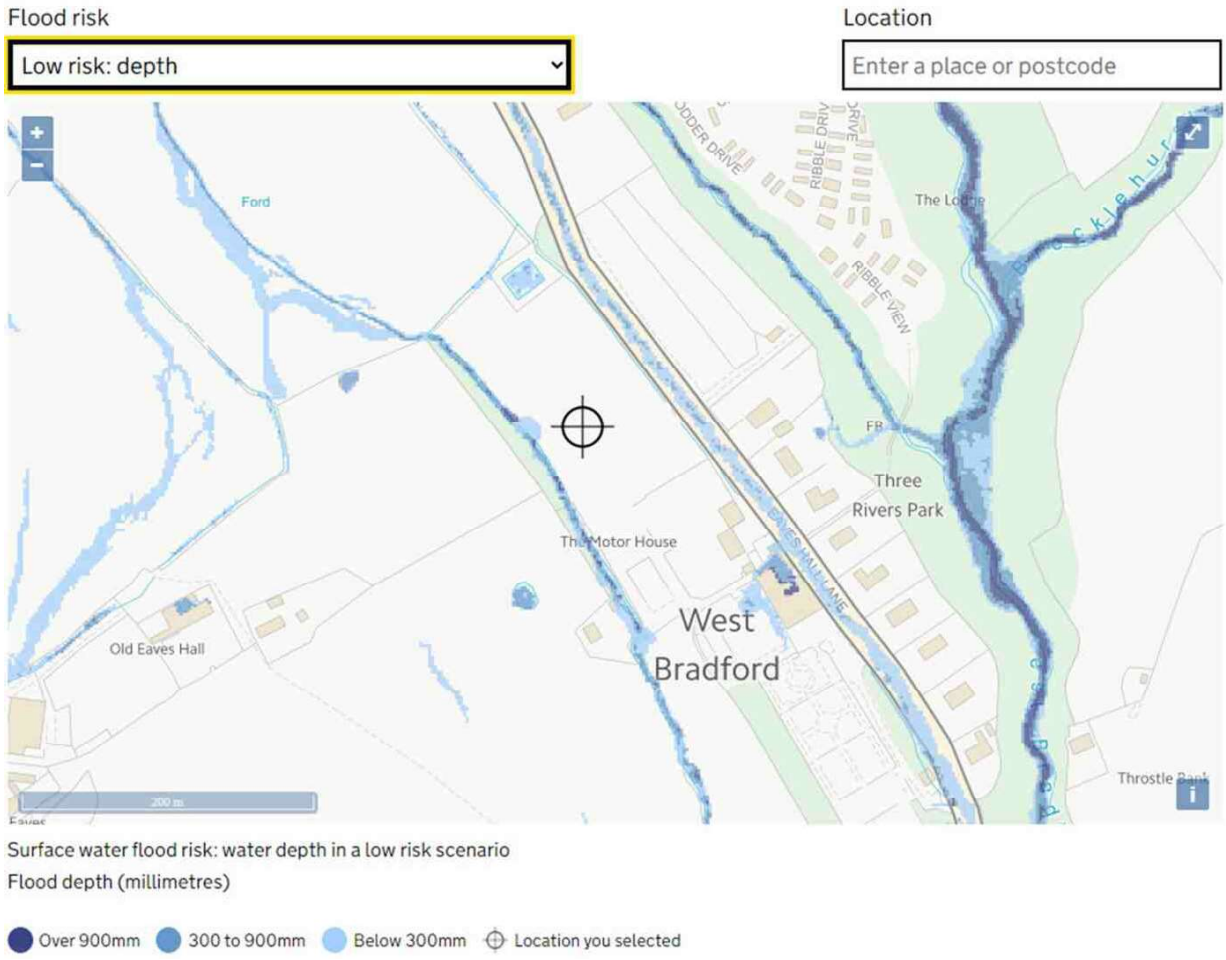
Location (easting/northing)
373677/444962

Scale
1:2500

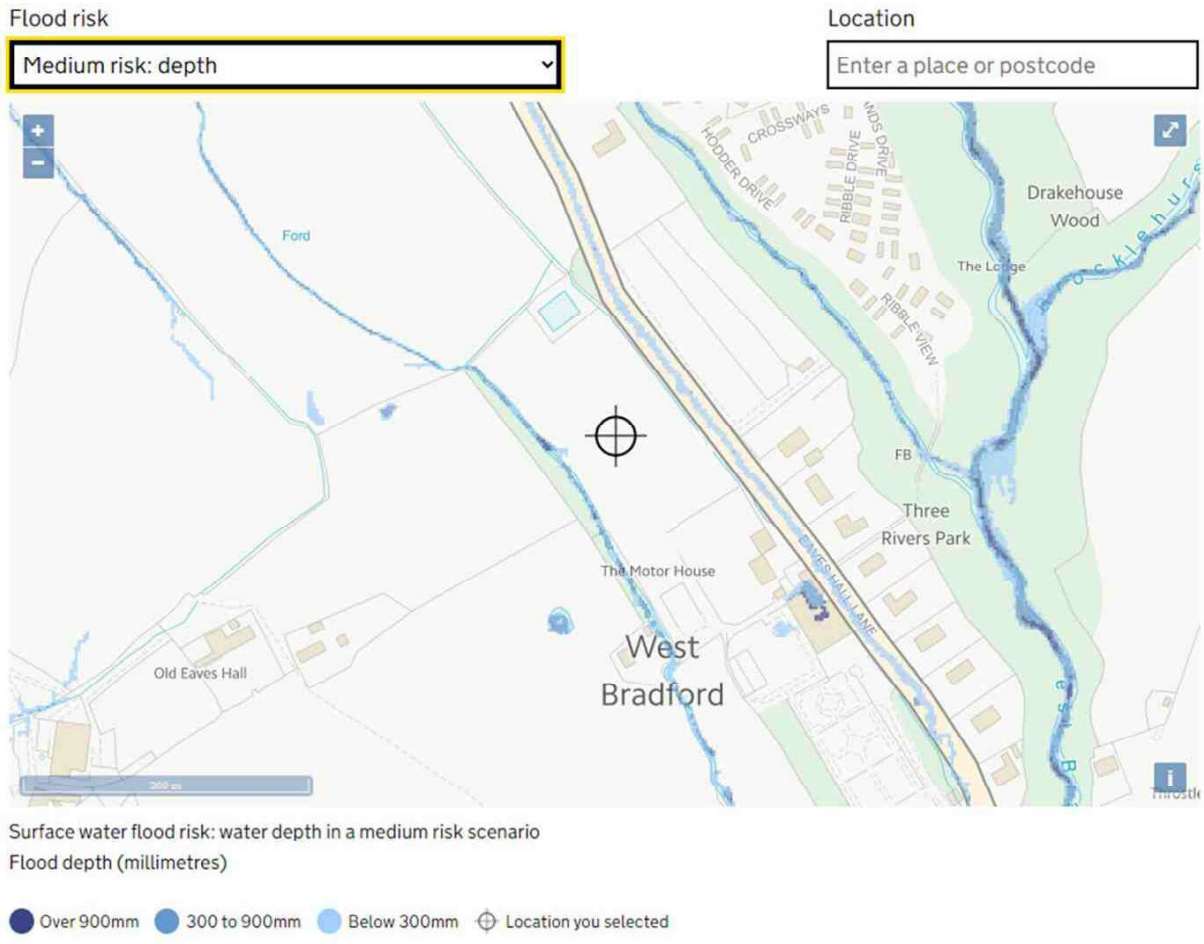
Created
30 Sep 2020 11:45

- Selected point
- Flood zone 3
- Flood zone 3: areas benefitting from flood defences
- Flood zone 2
- Flood zone 1
- Flood defence
- Main river
- Flood storage area

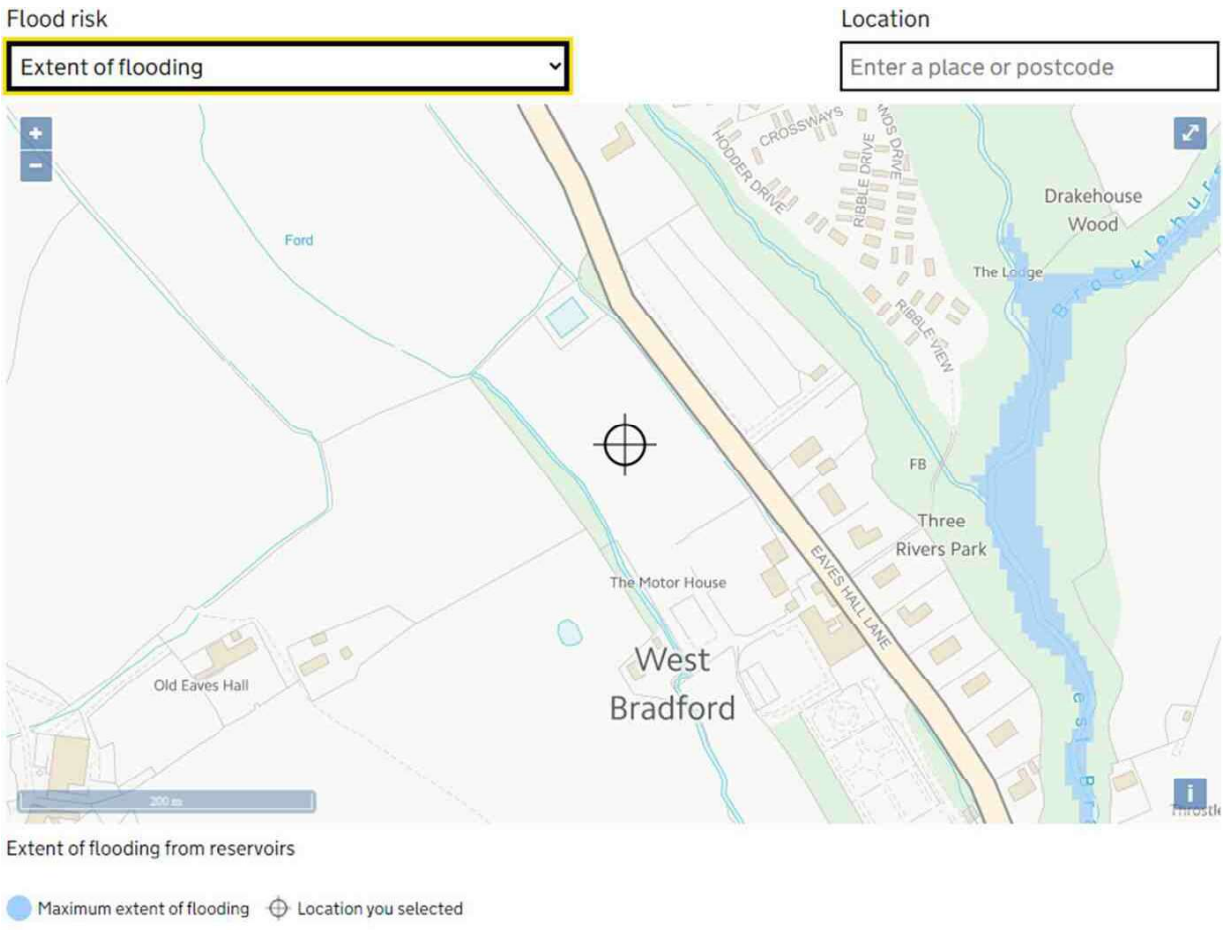
0 20 40 60m



SW flood risk – Low



SW flood risk – Medium



Flooding from reservoirs

Anna Mierzejewska

From: Reynolds, Helen <helen.reynolds02@environment-agency.gov.uk>
Sent: 29 October 2020 08:04
To: Anna Mierzejewska
Subject: CL187384HR

Dear Anna

Enquiry regarding Eaves Hall, Moor Lane, Bradford, BB7 3JG.

Thank you for your enquiry received on 1 October 2020.

We respond under the Freedom of Information Act 2000 and Environment Regulations 2004.

I believe the infiltration will relate to the surface water which is within the remit of the Local Lead Flood Authority. You will need to look into the SUDs hierarchy when assessing the infiltration method.

It looks like the closest watercourse to the site is classed as an ordinary watercourse which is within the remit of the LLFA.

Further downstream West Bradford brook is classed as a Main River which would be in the remit of the Environment Agency. If you want further advice on the main river, please get in contact, however, advice may be subject to charged advice through our Sustainable Places Team depending on the information required.

A new outfall on the Main River would require a flood risk activity permit.

Please refer to the Open Government Licence which explains ther permitted use for this information.

Please get in touch if you have any further queries or contact us within 2 months if you would like us to review the information we have sent.

Kind regards.

Helen Reynolds
Customer Engagement officer
Cumbria and Lancashire

Helen Reynolds
Customer and Engagement Officer
Cumbria and Lancashire

02030255754

Appendix D

Consultee Correspondence

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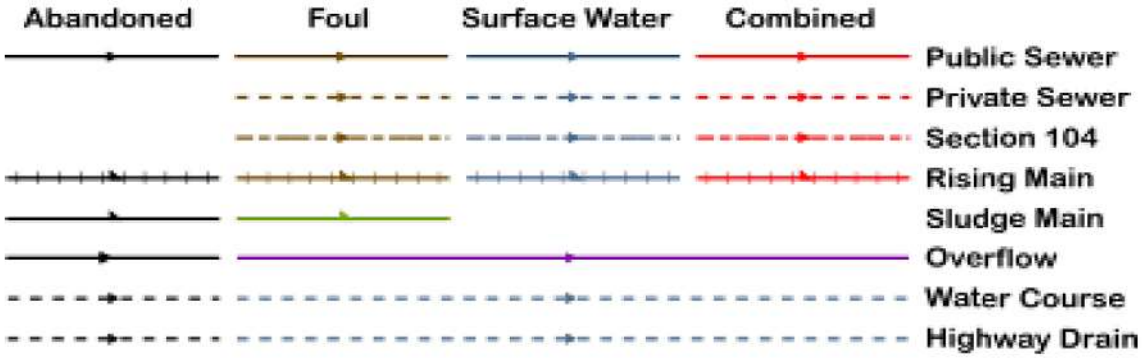
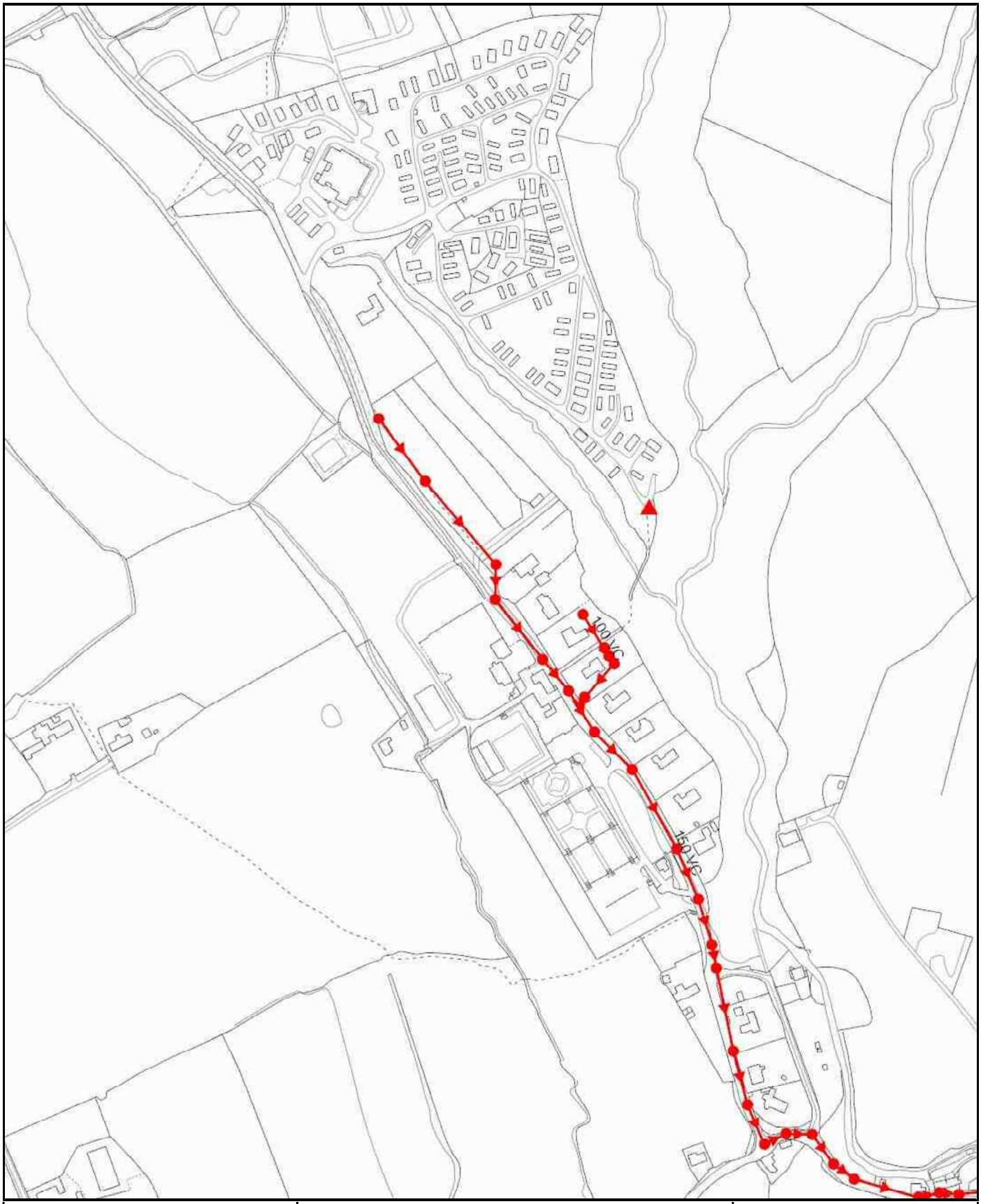
United Utilities
Water for the North West

Wastewater Symbology



All point assets follow the standard colour convention: red – combined, brown - foul, blue – surface water, purple - overflow

- Manhole
- HS Head of System
- ES Extent of Survey
- RE Rodding Eye
- IN Inlet
- DP Discharge Point
- HY Vortex
- PE Penstock
- WO Washout Chamber
- VA Valve
- AV Air Valve
- NRV Non Return Valve
- SO Soakaway
- GU Gully
- CA Cascade
- FM Flow Meter
- HA Hatch Box
- OI Oil Interceptor
- SM Summit
- DS Drop Shaft
- OP Orifice Plate
- Side Entry Manhole
- Outfall
- Screen Chamber
- IC Inspection Chamber
- Bifurcation Chamber
- LH Lamp Hole
- T Junction / Saddle
- CA Catchpit
- VC Valve Chamber
- Vent Column
- Vortex Chamber
- Penstock Chamber
- T Network Storage Tank
- V Sewer Overflow
- WwTW Ww Treatment Works
- Ww Pumping Station
- Septic Tank
- CK Control Kiosk
- Change of Characteristic



Scale:	1:4432
Date:	07/10/2020

SEWER RECORDS

United Utilities
Water for the North West

Address or Site Reference: EAVES HALL EAVES HALL LANE, WEST BRADFORD, CLITHEROE, BB7 3JG

Printed by: Property Searches

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

Anna Mierzejewska

From: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Sent: 12 October 2020 09:42
To: Anna Mierzejewska; Wastewater Developer Services
Subject: PDE 4200034005 Eaves Hall, Moor Lane, West Bradford, BB7 3JG

Good morning Anna,

I hope you are well.

Regarding you request for historic flood events in the area, unfortunately United Utilities don't offer this service anymore.

As this site is Greenfield in nature internal sewer flooding is not possible. However, for future reference, if there are any issues with internal flooding our call centre will be happy to help on 0345 672 3723.

The website link below gives you all the information on what to do in an emergency.

https://www.unitedutilities.com/emergencies/got-a-problem/flooding/sewage-flooding-your-home-or-garden/

We have carried out an assessment of your application which is based on the information provided. This pre-development advice on your drainage strategy will be valid for 12 months. Your drainage strategy will need to be reviewed by other competent authorities as part of the planning process, and we advise that you carry out the necessary site investigations to confirm the viability of your proposals.

If your investigations require access to our public sewer network, we ask that you contact our network engineers with a request for an access certificate via our main contact telephone number 0345 3723223 or refer to the link below:

https://www.unitedutilities.com/builders-developers/working-near-our-assets/

Foul Water

Foul flow from this site will be allowed to drain into the public foul water/combined sewer system.

Our preferred point of discharge would be to the 150mm diameter public combined sewer within Moor Lane located to the east of your proposed development at an unrestricted rate.

If you are able to identify an alternative, more suitable point of discharge, we request that you contact us at your earliest convenience so that we can assess suitability.

In accordance with our infrastructure plans we may ask you to change your point of connection. Therefore please contact us when you are ready to formalise your drainage proposals, we would suggest before you submit for Full Planning.

Surface Water

All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80, (Reference ID: 7-080-20150323), of the National Planning Practice Guidance. We also recommend you prioritise the use of multi-functional sustainable drainage systems for the management of surface water in accordance with national planning policy.

Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable.

This is outlined as follows, in order of priority:

1. **into the ground (infiltration);**
2. **to a surface waterbody;**
3. **to a surface water sewer or highway drain;**
4. **to a combined sewer.**

For guidance, The North West SuDS Pro-Forma provides information on the appropriate evidence required at each stage of the hierarchy, to demonstrate how each level has been discounted.

The Lead Local Flood Authority has responsibility for all surface water drainage concerns and their input to your proposal is critical. You should also consider whether it is necessary to discuss your proposal with the Environment Agency, or Internal Drainage Board (if operating in your area).

The Local Planning Authority are the determining authority for any application for planning permission and the appropriate authority for determining cost viability of a proposed drainage scheme, such assessments are outside of the jurisdiction of United Utilities.

Infiltration

Surface water runoff generated from this development should discharge to the ground via infiltration system where feasible.

The borehole logs you have provided for the area seems to suggest that an infiltration based drainage solution will be unlikely in this area. However, you may wish to investigate this option further for completeness by providing a detailed evidence based feasibility assessment must be carried out in line with Chapter 25 of the CIRIA SuDS Manual 2015 to determine whether infiltration is a suitable method of surface water disposal.

Particular attention must be paid to Ground Water Source Protection Zones to ensure that the risk of pollution to these valuable resources is not compromised. Details can be obtained from the government website:

https://www.gov.uk/guidance/groundwater-source-protection-zones-spzs#find-groundwater-spzs

If your site is in a Groundwater Source Protection Zone, you should have regard to the Environment Agency's approach to Groundwater Protection. Information on this is available via the link below:

https://www.gov.uk/government/publications/groundwater-protection-position-statements

Please note that such a location could have implications for the principle of your development and the need for additional mitigating measures to protect the groundwater environment and public water supply in the detailed design of your site.

Waterbody

If an evidence based assessment has been carried out and confirms that infiltration is not feasible, we recommend that you contact the Lead Local Flood Authority and/or Environment Agency to discuss a point of discharge to an nearby open watercourse. According to our records there is a watercourse located on the north-eastern boundary which flows around the site and discharges into the a watercourse on the south-western boundary named Greg Syke.

We strongly encourage the utilisation of these watercourses for the disposal of surface water from the proposed development site and if they are not within the site boundary we suggest you to identify and engage with any third party landowner and riparian owner to agree access and discharge rights to the water body if this is not in your ownership.

Highway Drainage

If an evidence based assessment has been carried out and confirms that infiltration is not feasible, we recommend that you investigate the possibility of draining surface water to the highway drain where this ultimately discharges to a watercourse, by contacting the relevant Highway Authority.

Public Sewer

In accordance with the hierarchy of drainage options within the National Planning Practice Guidance, discharge to ground via infiltration. discharge to a waterbody and/or to a highway drainage system should be discounted prior to consideration of discharging surface water to the public sewer system. Evidence should be provided to demonstrate how these have been discounted, as outlined in the North West SuDS pro-forma.

Given the presence of watercourses on a number of site boundaries, discharging to a public sewer system is not considered an appropriate option; however, if sufficient evidence to rule out all more sustainable options can be provided for assessment as outlined above, United Utilities will consider a connection to the 150mm diameter public combined sewer located to the east of the proposed development within Moor Lane at a pass forward flow to be agreed by the Lead Local Flood Authority. United Utilities request that any agreed rate does not exceed 5l/s.

As a Water Company, we have no obligation to accept highway drainage into our public sewer network. However, should your proposals include runoff from highways, we would request that consideration is given to SuDS components that deliver source control are incorporated within the design of the scheme to reduce the volume and frequency of discharges of these flows to the public sewer.

Levels

For low-lying sites, (where the ground level of the site or the level of a basement is below the ground level at the point where the drainage connects to the public sewer), care should be taken to ensure that the property is not at increased risk of flooding. If these circumstances exist, we recommend that you contact us to discuss further. It could affect the detailed design of your site and result in the need to incorporate appropriate mitigating measures in your drainage scheme.

Existing Water Assets Crossing the Site

It is the developer responsibility to identify utilities on-site. Where clean water assets are shown on our records, we recommend that you contact our Water Pre-Development Team, via the following email address: DeveloperServicesWater@uuplc.co.uk. Further information for this service can be found on our website via the link below:

https://www.unitedutilities.com/builders-developers/larger-developments/pre-development/water-pre-dev/

Our records indicate that there is a reservoir located immediately to the north of the proposed site, which should be investigated and considered.

Connection Application

Although we may discuss and agree discharge points and rates in principle, please be aware that you will have to apply for a formal sewer connection. This is so that we can assess the method of construction, Health & Safety requirements and to ultimately inspect the connection when it is made. Details of the application process and the form itself can be obtained from our website by following the link below:

https://www.unitedutilities.com/builders-developers/larger-developments/wastewater/sewer-connections/

We recommend that the detailed design should confirm the locations of all utilities in the area and ensure that any proposed drainage solution considers routing and clash checks where required.

If we can be of any further assistance please don't hesitate to contact us further.

Kind regards,

Robert Brenton
Developer Engineer
Developer Services & Metering
Customer Services
M: 07880299827
unitedutilities.com

If you have received a great service today why not tell us?
Visit: unitedutilities.com/wow

Did you know we now have a live chat facility available to you Mon to Friday 8 -5pm. You just click on the orange live chat box on our webpage and one of our advisors will be ready to chat to you and help you with your enquiry https://www.unitedutilities.com/builders-developers/ or you can email us at developerserviceswater@uuplc.co.uk

From: Anna Mierzejewska [mailto:a.mierzejewska@thelkgroup.com]
Sent: 30 September 2020 12:54
To: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Subject: FRA Enquiry - Eaves Hall, Moor Lane, West Bradford, BB7 3JG

Re: Planning Application ref: 3/2020/0544

Dear Sir/Madam,

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment and Outline Drainage Strategy, for a site located to the southwest of Moor Lane, West Bradford, BB7 3JG, centred at approximate National Grid Reference 373655E, 444990N. The site is being proposed for a construction of 15 eco lodges and infrastructure to provide additional accommodation to Eaves Hall.

The area of interest appears to be within Flood Zone 1 with a low risk from surface water along the onsite watercourse.

BGS data indicates that the site is within an area underlain by Till, Devensian superficial deposits and Clitheroe Limestone Formation and Hodder Mudstone Formation bedrock. The nearest borehole records suggest a deep bounder clay strata is expected below the site area.

A watercourse runs within the site along the SW boundary which is an estuary of Drakehouse Brook. It flows towards SE.

The site location, topographical survey, nearest borehole records, Greenfield calculations and Pre-development enquiry form are attached to this email.

To complete the FRA and SuDS, we would be grateful if you could supply us with the following, if available, for the vicinity of the site:

- Records of any historic flood events and potential sources of flooding from foul and surface water sewers on site and in the area.
- Any restrictions to discharge into the sewers

If you have any queries, please do not hesitate to get in touch.

We will be in contact with all other relevant authorities to get a more complete understanding of the issues in the area.

Regards,
Anna

Anna Mierzejewska MSc
Environmental Scientist
LK Group | 0161 763 7200 |07515 051 602
Manchester | London | Liverpool | Glasgow
www.thelkgroup.com

INCREASING LAND VALUE

Appendix E

Calculations

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MasterDrain
HY 10.07

The LK Group
www.thelkgroup.com

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Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.			
Sheet no.	1		
Date	30/10/20		
Project	Greenfield runoff	By	Checked / Reviewed
Title	IoH 124 Runoff calcs for Eaves Hall, Moor Lane		

Hydrological Data:-

FSR Hydrology:-

Location = Eaves Hall, Moor Lane Grid reference = SD7445
M5-60 (mm) = 19.9 r = 0.25
Soil runoff = 0.50 SAAR (mm/yr) = 1220
WRAP = 5 Area = England & Wales
Hydrological area = 10 Hydrological zone = 6

Soil classification for WRAP type 5
Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

Design data:-

Area = 0.0126 Km^2 - 1.26 Ha - 12600 m^2

Calculation method:-

Runoff is calculated from:-

$$Q_{BAR(rural)} = 0.00108\ AREA^{0.89} \cdot SAAR^{1.17} \cdot SOIL^{2.17}$$

where

AREA = Site area in Km^2
SAAR = Standard Average Annual Rainfall (mm/yr)
SOIL = Soil value derived from Winter Rainfall Acceptance Potential
$Q_{BAR(rural)}$ = Runoff (cumecs)

$Q_{BAR(rural)}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

Calculated data:-

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.025

Mean Annual Peak Flow $Q_{BAR(rural)}$ = 13.33 l/s

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HY 10.07

Job No.			
Sheet no.	2		
Date	30/10/20		
Project: Greenfield runoff	By	Checked	Reviewed
Title: IoH 124 Runoff calcs for Eaves Hall, Moor Lane			

Values for $Q_{BAR(rural)}$

Ret. per.	m³/hr	l/s	l/s/ha	Ret. per.	m³/hr	l/s	l/s/ha
1yr	40.779	11.327	8.990	100yr+20%	120.897	33.583	26.653
2yr	44.617	12.394	9.836	100yr+30%	130.972	36.381	28.874
5yr	58.050	16.125	12.798	100yr+40%	141.047	39.180	31.095
10yr	66.206	18.390	14.596	200yr	115.140	31.983	25.384
30yr	80.598	22.388	17.769	200yr + 30%	149.682	41.578	32.999
50yr	88.754	24.654	19.567	500yr	130.972	36.381	28.874
100yr	100.748	27.985	22.211	1000yr	145.844	40.512	32.153

Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.93	1.21	1.38	1.68	1.85	2.10	2.40	2.73	3.04

The above is based on the Institute of Hydrology Report 124
to which you are referred for further details (see Sect 7).
Note that the 200 and above year growth curves were taken from W5-074.

MasterDrain SW

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email: m.jones@thelkgroup.com

Job No.			
Sheet no.	1		
Date	30/10/20		
Project	30yr	By	Checked / Reviewed
Title	Peak flow storage calcs for Eaves Hall, Moor Lane		

Data:-

FSR Hydrology:-

Location = Eaves Hall, Moor Lane
M5-60 (mm) = 19.9
Soil index = 0.50
Return period = 30
UCWI = 123.1

Grid reference = SD7445
r = 0.25
SAAR (mm/yr) = 1220
WRAP = 5
Climate change = 0

Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

Runoff factor (RF) = 8.0, calculated from:-

Runoff factor = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7

where

PIMP = Impervious Area*100/(Impervious Area+Pervious Area)

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 1000 m²
Total area (TA) = 12600 m²
Allowed discharge rate = 22.390 l/s
Additional flow = 0.00 l/s

Pervious area = 11600 m²
Equiv area = 1008 m² (TA x RF).
Areal reduction factor = 1.000
Climate change factor = 0

Calculated data:-

Time to max = 43.0 mins
Rainfall at max = 37.17 mm/hr
Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Calculated storage volume = 76.5 m³
Allowed discharge rate = 22.390 l/s
Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours
Rainfall rate = 10.00 mm/hr

Calculated storage volume = 0.0 m³
Allowed discharge rate = 22.390 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len
100	9741.4	1125	77.0
150	4329.5	1200	67.6
225	1924.2	1275	59.9
300	1082.4	1350	53.5
375	692.7	1425	48.0
450	481.1	1500	43.3
525	353.4	1575	39.3
600	270.6	1650	35.8
675	213.8	1725	32.7
750	173.2	1800	30.1
825	143.1	1875	27.7
900	120.3	1950	25.6
975	102.5	2025	23.8
1050	88.4	2100	22.1

Ovoid	Len
400 x 600	425.0
600 x 900	185.0
800 x 1200	104.1

Box culvert	Len
500 x 500	306.0
500 x 750	204.0
500 x 1000	153.0
750 x 1000	102.0
750 x 1200	85.0
750 x 1500	68.0
1000 x 1000	76.5
1000 x 1200	63.7
1000 x 1500	51.0
1000 x 1800	42.5
1000 x 2000	38.2
1500 x 1500	34.0
1500 x 1800	28.3
1500 x 2000	25.5

The LK Group
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email: m.jones@thelkgroup.com

Job No.	
Sheet no.	2
Date	30/10/20

MasterDrain SW

Project	30yr	By	Checked / Reviewed
Title	Peak flow storage calcs for Eaves Hall, Moor Lane		

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	77.0	64.775	13.434	51.341
20	56.0	94.185	26.868	67.317
30	45.0	114.327	40.302	74.025
40	39.0	130.096	53.736	76.360
50	34.0	143.208	67.170	76.038
60	31.0	154.498	80.604	73.894
70	28.0	164.445	94.038	70.407
80	26.0	173.351	107.472	65.879
90	24.0	181.420	120.906	60.514
100	22.0	188.800	134.340	54.460
110	21.0	195.596	147.774	47.822
120	20.0	201.894	161.208	40.686
130	19.0	207.757	174.642	33.115
140	18.0	213.237	188.076	25.161
150	17.0	218.378	201.510	16.868
160	17.0	223.214	214.944	8.270
170	16.0	227.776	228.378	0.000
180	15.0	232.327	241.812	0.000
190	15.0	236.699	255.246	0.000
200	14.0	240.908	268.680	0.000
210	14.0	244.969	282.114	0.000
220	13.0	248.893	295.548	0.000
230	13.0	252.691	308.982	0.000
240	13.0	256.371	322.416	0.000
250	12.0	259.943	335.850	0.000
260	12.0	263.413	349.284	0.000
270	12.0	266.788	362.718	0.000
280	11.0	270.075	376.152	0.000
290	11.0	273.278	389.586	0.000
300	11.0	276.403	403.020	0.000
310	11.0	279.453	416.454	0.000
320	11.0	282.433	429.888	0.000
330	10.0	285.347	443.322	0.000
340	10.0	288.198	456.756	0.000
350	10.0	290.989	470.190	0.000
360	10.0	293.723	483.624	0.000
370	10.0	296.402	497.058	0.000
380	9.0	299.030	510.492	0.000
390	9.0	301.609	523.926	0.000
400	9.0	304.140	537.360	0.000
410	9.0	306.625	550.794	0.000
420	9.0	309.068	564.228	0.000
430	9.0	311.468	577.662	0.000
440	8.0	313.829	591.096	0.000
450	8.0	316.151	604.530	0.000
460	8.0	318.436	617.964	0.000
470	8.0	320.685	631.398	0.000
480	8.0	322.900	644.832	0.000
490	8.0	325.082	658.266	0.000
500	8.0	327.232	671.700	0.000
510	8.0	329.351	685.134	0.000
520	8.0	331.440	698.568	0.000
530	7.0	333.500	712.002	0.000
540	7.0	335.532	725.436	0.000
550	7.0	337.536	738.870	0.000
560	7.0	339.515	752.304	0.000
570	7.0	341.468	765.738	0.000
580	7.0	343.396	779.172	0.000
590	7.0	345.301	792.606	0.000
600	7.0	347.182	806.040	0.000

Storage volume (m^3) = 76.5 m^3

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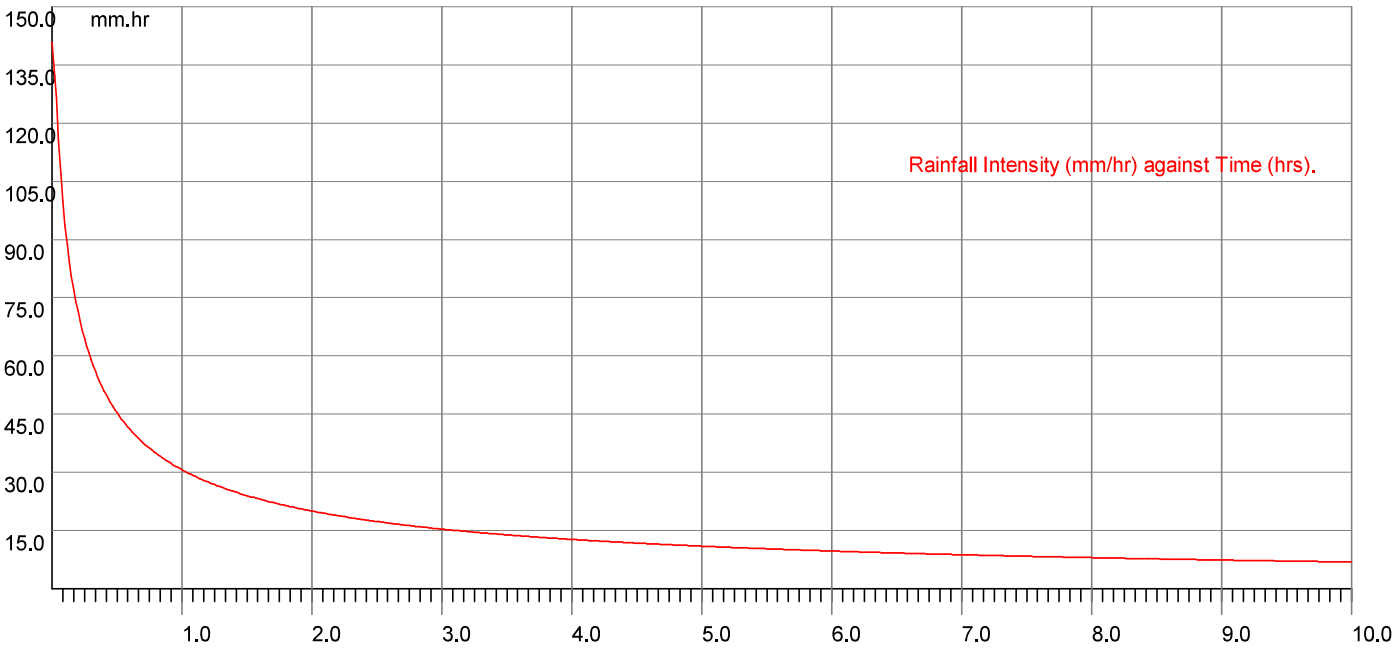
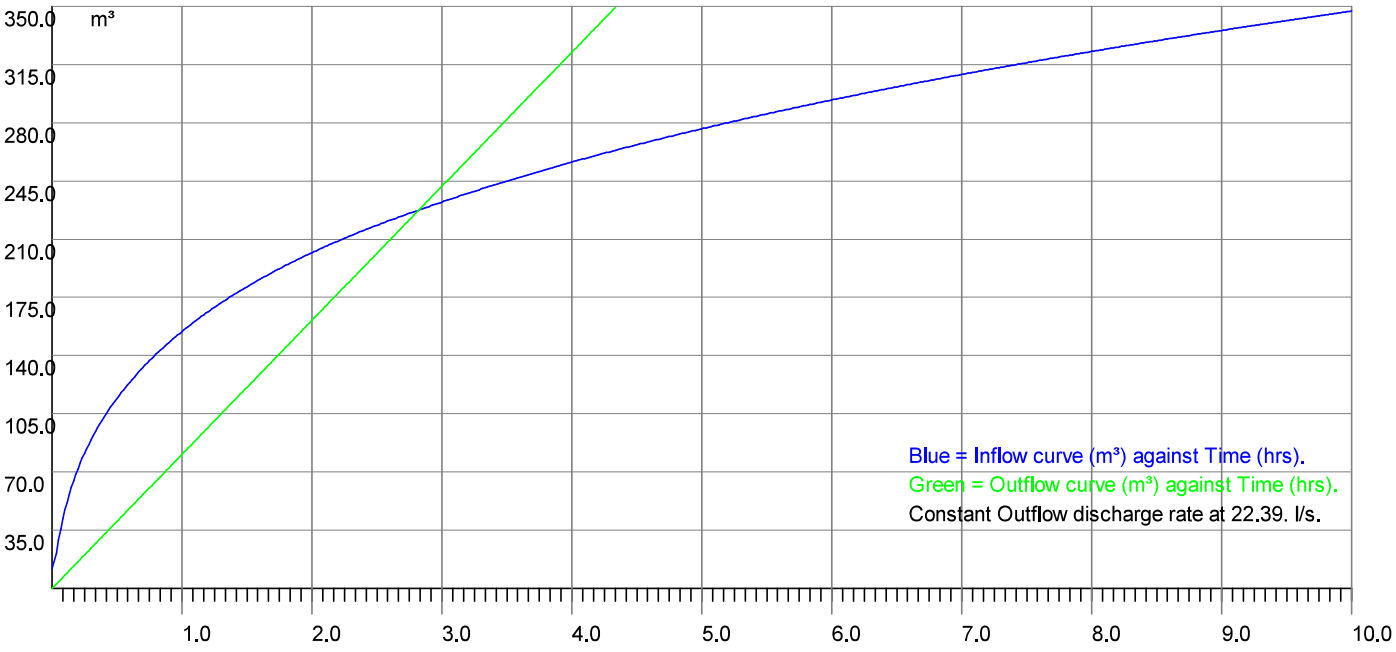
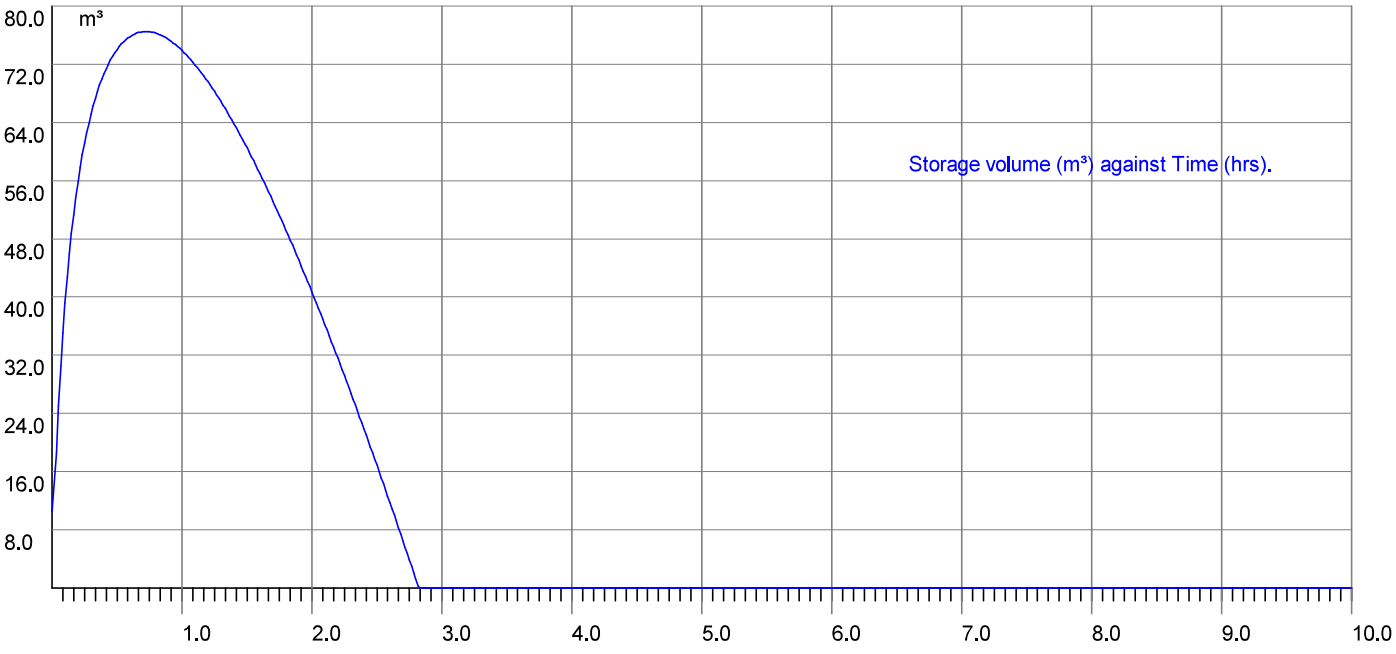
		Sheet no.	3
		Date	30/10/20
Project 30yr		By	Checked / Reviewed
Title **Peak flow storage calcs for Eaves Hall, Moor Lane**			







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Job No.			
Sheet no.	1		
Date	30/10/20		
Project	100yr plus 20% climate change	By	Checked / Reviewed
Title	Peak flow storage calcs for Eaves Hall, Moor Lane		

Data:-

FSR Hydrology:-

Location = Eaves Hall, Moor Lane
M5-60 (mm) = 19.9
Soil index = 0.50
Return period = 100
UCWI = 123.1

Grid reference = SD7445
r = 0.25
SAAR (mm/yr) = 1220
WRAP = 5
Climate change = 20

Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

Runoff factor (RF) = 8.0, calculated from:-

Runoff factor = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7

where

PIMP = Impervious Area*100/(Impervious Area+Pervious Area)

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 1000 m²
Total area (TA) = 12600 m²
Allowed discharge rate = 27.990 l/s
Additional flow = 0.00 l/s

Pervious area = 11600 m²
Equiv area = 1008 m² (TA x RF).
Areal reduction factor = 1.000
Climate change factor = 20

Calculated data:-

Time to max = 60.0 mins
Rainfall at max = 48.36 mm/hr
Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Calculated storage volume = 143.0 m³
Allowed discharge rate = 27.990 l/s
Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours
Rainfall rate = 15.00 mm/hr

Calculated storage volume = 0.0 m³
Allowed discharge rate = 27.990 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len
100	18207.8	1125	143.9
150	8092.4	1200	126.4
225	3596.6	1275	112.0
300	2023.1	1350	99.9
375	1294.8	1425	89.7
450	899.2	1500	80.9
525	660.6	1575	73.4
600	505.8	1650	66.9
675	399.6	1725	61.2
750	323.7	1800	56.2
825	267.5	1875	51.8
900	224.8	1950	47.9
975	191.5	2025	44.4
1050	165.2	2100	41.3

Ovoid	Len
400 x 600	794.3
600 x 900	345.9
800 x 1200	194.5

Box culvert	Len
500 x 500	571.9
500 x 750	381.3
500 x 1000	286.0
750 x 1000	190.6
750 x 1200	158.9
750 x 1500	127.1
1000 x 1000	143.0
1000 x 1200	119.1
1000 x 1500	95.3
1000 x 1800	79.4
1000 x 2000	71.5
1500 x 1500	63.5
1500 x 1800	53.0
1500 x 2000	47.7

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Job No.	
Sheet no.	2
Date	30/10/20

MasterDrain SW

Project	100yr plus 20% climate change	By	Checked / Reviewed
Title	Peak flow storage calcs for Eaves Hall, Moor Lane		

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	118.0	99.258	16.794	82.464
20	87.0	146.597	33.588	113.009
30	71.0	179.109	50.382	128.727
40	61.0	204.569	67.176	137.393
50	54.0	225.668	83.970	141.698
60	48.0	243.741	100.764	142.977
70	44.0	259.559	117.558	142.001
80	41.0	273.613	134.352	139.261
90	38.0	286.240	151.146	135.094
100	35.0	297.681	167.940	129.741
110	33.0	308.117	184.734	123.383
120	32.0	317.686	201.528	116.158
130	30.0	326.499	218.322	108.177
140	28.0	334.644	235.116	99.528
150	27.0	342.194	251.910	90.284
160	26.0	349.210	268.704	80.506
170	25.0	355.744	285.498	70.246
180	24.0	362.444	302.292	60.152
190	23.0	368.868	319.086	49.782
200	22.0	375.039	335.880	39.159
210	22.0	380.980	352.674	28.306
220	21.0	386.708	369.468	17.240
230	20.0	392.241	386.262	5.979
240	20.0	397.593	403.056	0.000
250	19.0	402.778	419.850	0.000
260	19.0	407.805	436.644	0.000
270	18.0	412.687	453.438	0.000
280	18.0	417.432	470.232	0.000
290	17.0	422.049	487.026	0.000
300	17.0	426.545	503.820	0.000
310	17.0	430.928	520.614	0.000
320	16.0	435.202	537.408	0.000
330	16.0	439.376	554.202	0.000
340	16.0	443.453	570.996	0.000
350	15.0	447.438	587.790	0.000
360	15.0	451.337	604.584	0.000
370	15.0	455.153	621.378	0.000
380	14.0	458.890	638.172	0.000
390	14.0	462.551	654.966	0.000
400	14.0	466.141	671.760	0.000
410	14.0	469.662	688.554	0.000
420	13.0	473.116	705.348	0.000
430	13.0	476.508	722.142	0.000
440	13.0	479.839	738.936	0.000
450	13.0	483.112	755.730	0.000
460	13.0	486.328	772.524	0.000
470	12.0	489.491	789.318	0.000
480	12.0	492.601	806.112	0.000
490	12.0	495.662	822.906	0.000
500	12.0	498.674	839.700	0.000
510	12.0	501.639	856.494	0.000
520	12.0	504.560	873.288	0.000
530	11.0	507.437	890.082	0.000
540	11.0	510.272	906.876	0.000
550	11.0	513.066	923.670	0.000
560	11.0	515.821	940.464	0.000
570	11.0	518.537	957.258	0.000
580	11.0	521.216	974.052	0.000
590	11.0	523.859	990.846	0.000
600	10.0	526.468	1007.640	0.000

Storage volume (m^3) = 143.0 m^3

MasterDrain SW

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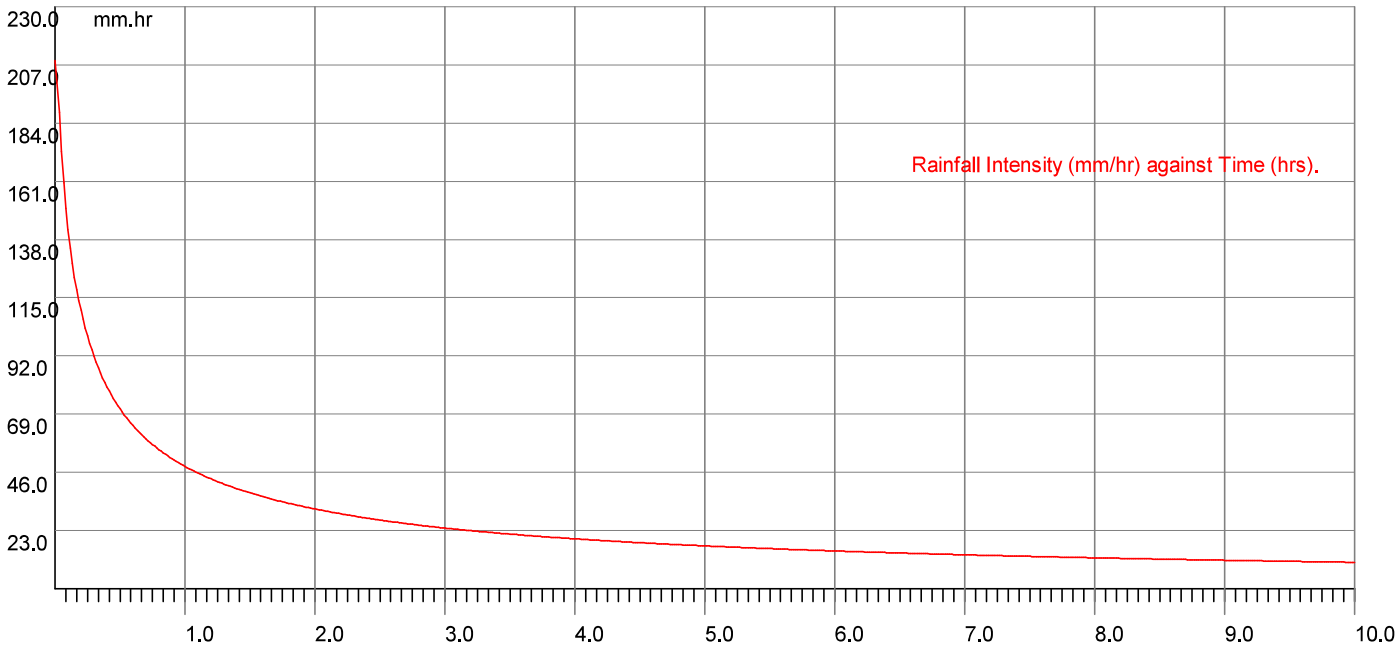
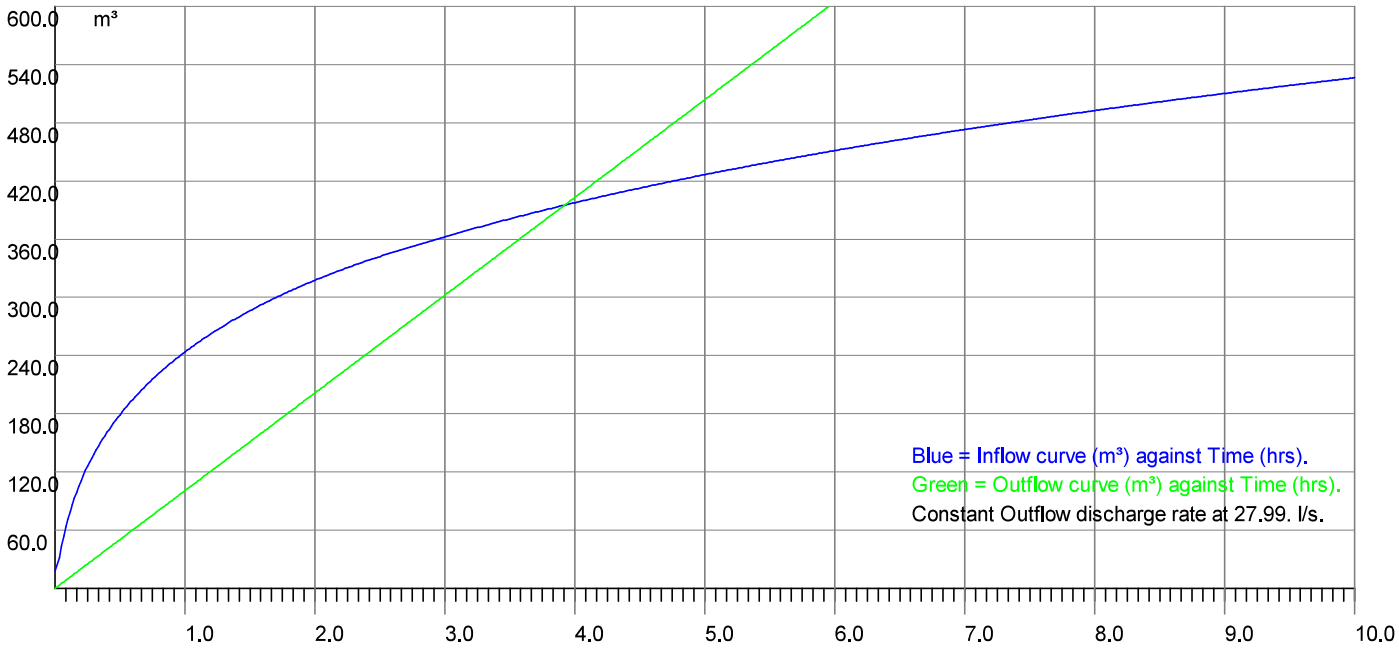
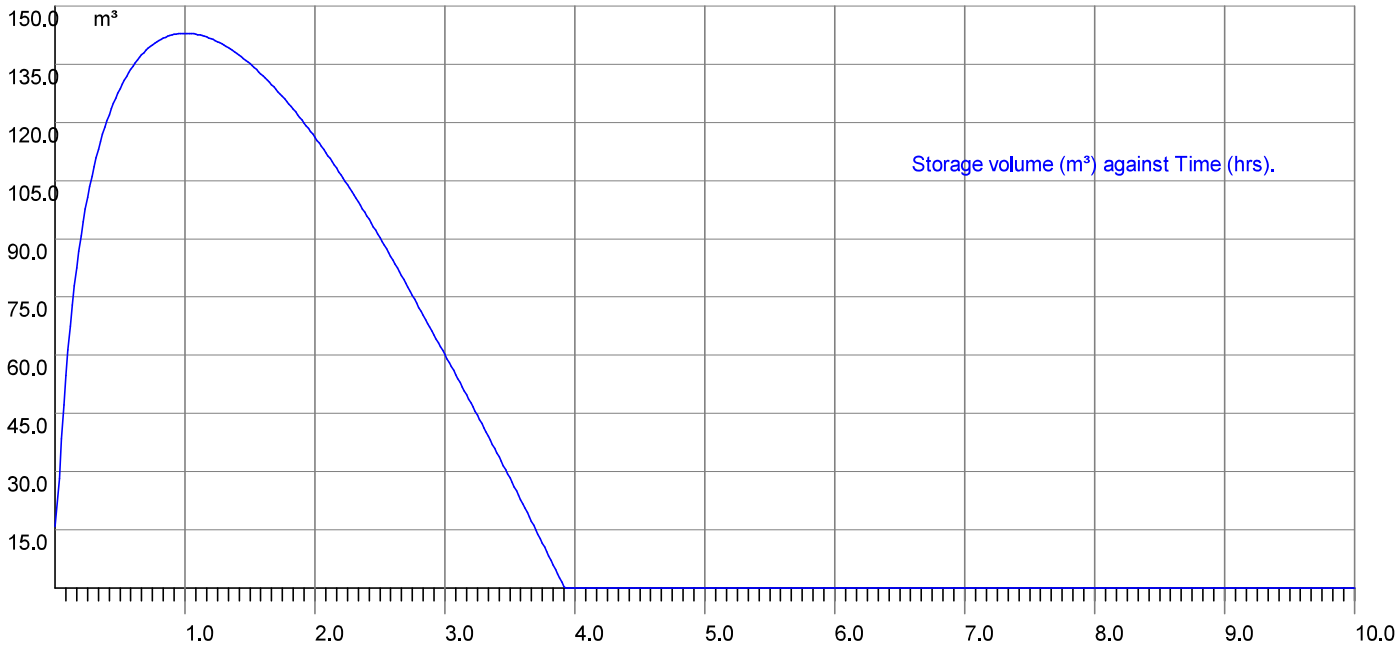
		Sheet no.	3
		Date	30/10/20
Project: **100yr plus 20% climate change**		By	Checked / Reviewed
Title: **Peak flow storage calcs for Eaves Hall, Moor Lane**			







MasterDrain SW

The LK Group	Eton Business Park, Eton Hill Road, Radcliffe M26 2ZS Tel: 0161 763 7200 email: m.jones@thelkgroup.com	Job No.		
www.thelkgroup.com		Sheet no. 1		
		Date 30/10/20		
Project 100yr plus 40% climate change		By	Checked	Reviewed
Title Peak flow storage calcs for Eaves Hall, Moor Lane				

Data:-

FSR Hydrology:-

Location = Eaves Hall, Moor Lane
M5-60 (mm) = 19.9
Soil index = 0.50
Return period = 100
UCWI = 123.1

Grid reference = SD7445
r = 0.25
SAAR (mm/yr) = 1220
WRAP = 5
Climate change = 40

Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

Runoff factor (RF) = 8.0, calculated from:-

Runoff factor = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7

where

PIMP = Impervious Area*100/(Impervious Area+Pervious Area)

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 1000 m²
Total area (TA) = 12600 m²
Allowed discharge rate = 27.990 l/s
Additional flow = 0.00 l/s

Pervious area = 11600 m²
Equiv area = 1008 m² (TA x RF).
Areal reduction factor = 1.000
Climate change factor = 40

Calculated data:-

Time to max = 73.0 mins
Rainfall at max = 50.22 mm/hr
Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Calculated storage volume = 185.3 m³
Allowed discharge rate = 27.990 l/s
Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours
Rainfall rate = 17.00 mm/hr

Calculated storage volume = 0.0 m³
Allowed discharge rate = 27.990 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len
100	23602.2	1125	186.5
150	10489.9	1200	163.9
225	4662.2	1275	145.2
300	2622.5	1350	129.5
375	1678.4	1425	116.2
450	1165.5	1500	104.9
525	856.3	1575	95.1
600	655.6	1650	86.7
675	518.0	1725	79.3
750	419.6	1800	72.8
825	346.8	1875	67.1
900	291.4	1950	62.1
975	248.3	2025	57.6
1050	214.1	2100	53.5

Ovoid	Len
400 x 600	1029.6
600 x 900	448.3
800 x 1200	252.1

Box culvert	Len
500 x 500	741.3
500 x 750	494.2
500 x 1000	370.7
750 x 1000	247.1
750 x 1200	205.9
750 x 1500	164.7
1000 x 1000	185.3
1000 x 1200	154.4
1000 x 1500	123.6
1000 x 1800	103.0
1000 x 2000	92.7
1500 x 1500	82.4
1500 x 1800	68.6
1500 x 2000	61.8

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Job No.	
Sheet no.	2
Date	30/10/20

MasterDrain SW

Project	100yr plus 40% climate change	By	Checked / Reviewed
Title	Peak flow storage calcs for Eaves Hall, Moor Lane		

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	138.0	115.801	16.794	99.007
20	102.0	171.030	33.588	137.442
30	83.0	208.961	50.382	158.579
40	71.0	238.664	67.176	171.488
50	63.0	263.280	83.970	179.310
60	56.0	284.364	100.764	183.600
70	51.0	302.818	117.558	185.260
80	48.0	319.215	134.352	184.863
90	44.0	333.946	151.146	182.800
100	41.0	347.294	167.940	179.354
110	39.0	359.469	184.734	174.735
120	37.0	370.634	201.528	169.106
130	35.0	380.915	218.322	162.593
140	33.0	390.418	235.116	155.302
150	32.0	399.227	251.910	147.317
160	30.0	407.412	268.704	138.708
170	29.0	415.034	285.498	129.536
180	28.0	422.851	302.292	120.559
190	27.0	430.346	319.086	111.260
200	26.0	437.546	335.880	101.666
210	25.0	444.476	352.674	91.802
220	24.0	451.160	369.468	81.692
230	24.0	457.615	386.262	71.353
240	23.0	463.859	403.056	60.803
250	22.0	469.907	419.850	50.057
260	22.0	475.773	436.644	39.129
270	21.0	481.468	453.438	28.030
280	21.0	487.004	470.232	16.772
290	20.0	492.390	487.026	5.364
300	20.0	497.636	503.820	0.000
310	19.0	502.749	520.614	0.000
320	19.0	507.736	537.408	0.000
330	18.0	512.605	554.202	0.000
340	18.0	517.361	570.996	0.000
350	18.0	522.011	587.790	0.000
360	17.0	526.560	604.584	0.000
370	17.0	531.011	621.378	0.000
380	17.0	535.371	638.172	0.000
390	16.0	539.643	654.966	0.000
400	16.0	543.831	671.760	0.000
410	16.0	547.938	688.554	0.000
420	16.0	551.969	705.348	0.000
430	15.0	555.926	722.142	0.000
440	15.0	559.812	738.936	0.000
450	15.0	563.630	755.730	0.000
460	15.0	567.383	772.524	0.000
470	14.0	571.072	789.318	0.000
480	14.0	574.701	806.112	0.000
490	14.0	578.272	822.906	0.000
500	14.0	581.786	839.700	0.000
510	14.0	585.246	856.494	0.000
520	13.0	588.653	873.288	0.000
530	13.0	592.010	890.082	0.000
540	13.0	595.317	906.876	0.000
550	13.0	598.577	923.670	0.000
560	13.0	601.791	940.464	0.000
570	13.0	604.960	957.258	0.000
580	12.0	608.085	974.052	0.000
590	12.0	611.169	990.846	0.000
600	12.0	614.212	1007.640	0.000

Storage volume (m^3) = 185.3 m^3

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MasterDrain SW

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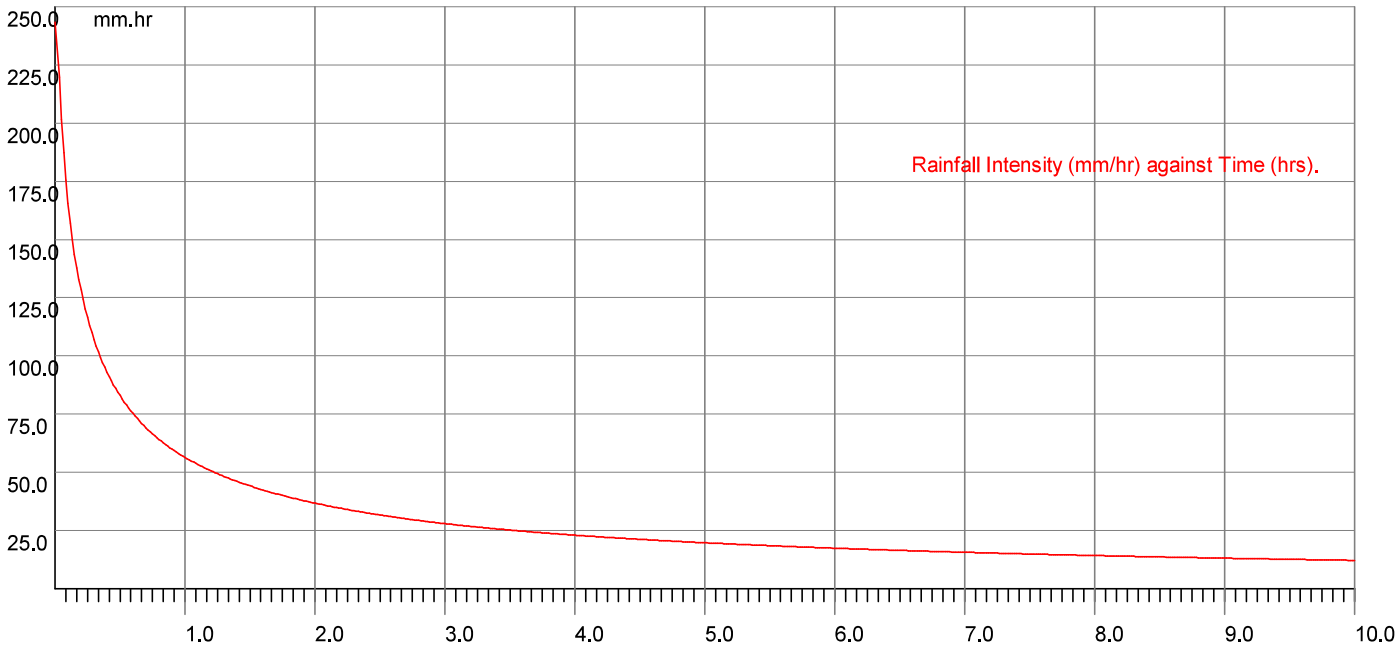

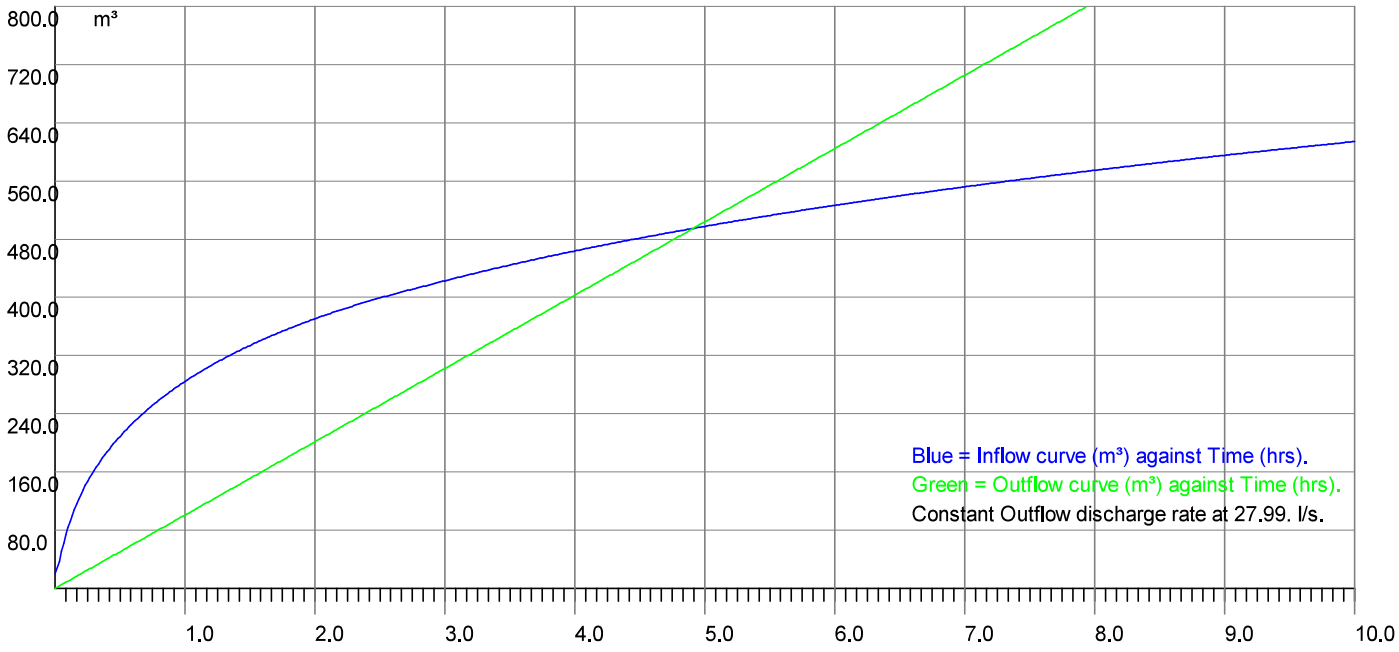

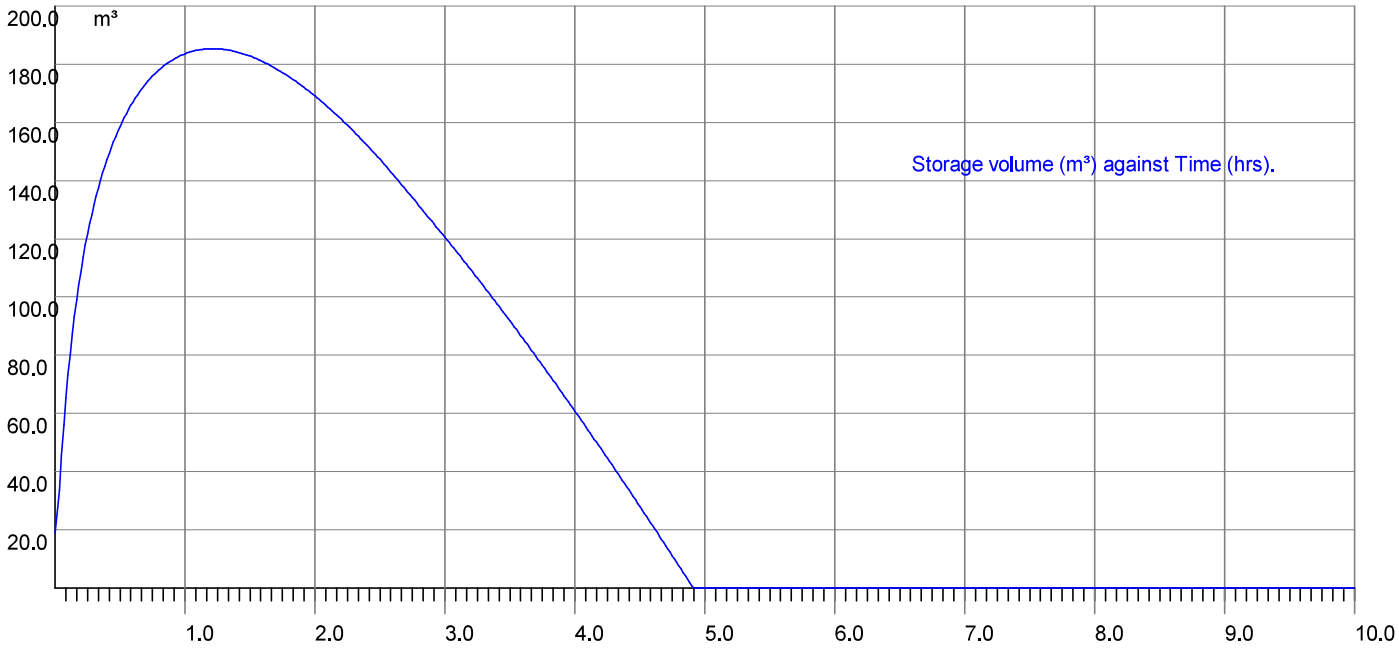

Explanatory notes for Peak Flow Storage

1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
2) The balance is calculated from the inflow minus the outflow.
3) The storage volume is the maximum value of the balance curve.
4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
5) References to 'storm duration' relate only to the hydrograph method (qv).
6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

1) The user has the choice of Summer or Winter curves
2) The mean intensity varies with the duration of the storm curve
3) There are always 120 steps in the calculation process, irrespective of storm duration.
4) The balance is calculated from the inflow minus the outflow.
5) The storage volume is the sum of the balance values for each step.
6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.

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